ILLUMINATING ENGINEERING

OCTOBER 1952

Mercury Lamps and Their Industrial Applications
Silhouette Lighting of Small Diameter Wires
Kinorama as Evaluator in Aviation Lighting
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Floodlighting Table Mountain

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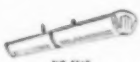
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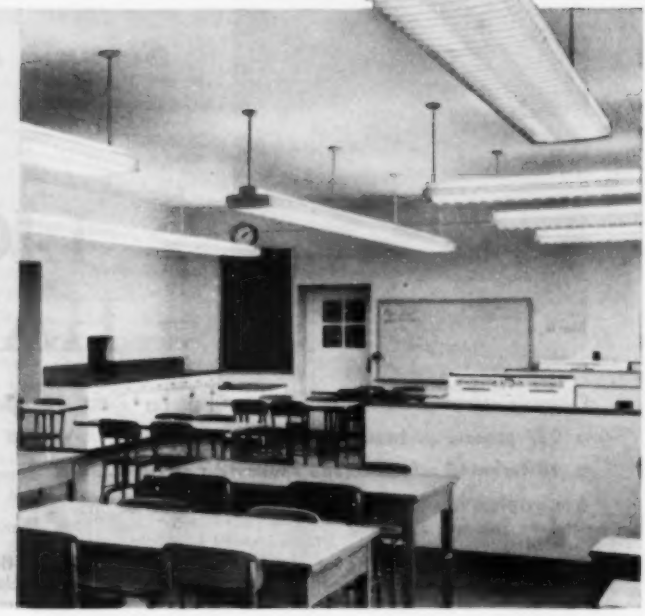

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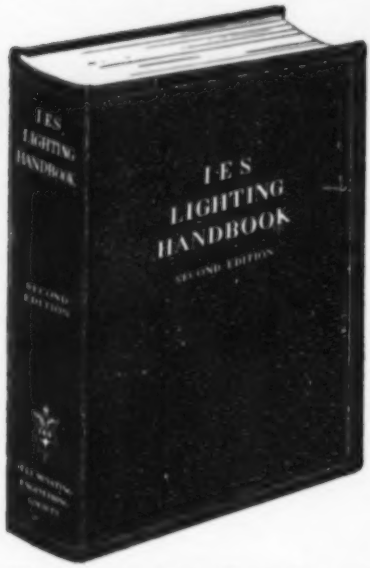

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

OCTOBER
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Everett M. Strong, President 1952-1953

Illuminating Engineering Society

IT HAS BEEN the Society's good fortune, on a number of occasions in the past, to have as its chief executive a man who is also a leader in the educational field. Once again in 1952-1953, the Illuminating Engineering Society has selected as its 48th President an educator eminent in illumination — Professor Everett M. Strong of Cornell University, Ithaca, New York.

Professor Strong brings to his office a background of steady, progressive achievement over some thirty years, in the interests of illuminating engineering. On his graduation in 1922 in electrical engineering and illumination from Massachusetts Institute of Technology, Professor Strong joined the Lamp Department of the General Electric Company at Nela Park, as an illuminating engineer. In 1924 he became a member of the Cornell faculty, as instructor in illumination and is at present Professor of Electrical Engineering in charge of the University's Engineering Industrial Cooperative Course, the Basic Theory Area and Illuminating Engineering.

Frequently sought as a consultant on important studies affecting the field, Professor Strong has himself conducted a number of projects, notably a study of cyclic flicker in fluorescent lamps, the results of which were presented in a paper before the Society in 1941. He is equally known for his researches in color, and for his development of demonstration equipment of special value in the teaching of lighting and electrical engineering fundamentals. Professor Strong's book "Electrical Engineering, Basic Analysis" was published in 1943 by Wiley & Sons, and continues as a leading text in that field.

In Society affairs, Professor Strong has been a distinguished contributor to I.E.S. progress since the first year of his election to membership in 1936. In addition to numerous committee assignments, he has served as a Director of the Society, and as Treasurer in 1948-1950, and was elected Vice-President in 1950. He took a most active part in the work of the basic committee on Standards of Quality and Quantity for Interior Illumination, from 1945 through the present, serving as chairman 1945-1947.

Active also in the work of the American Institute of Electrical Engineers, and the American Society for Engineering Education, Professor Strong has served those societies on numerous committees, and held office as the A.I.E.E. Ithaca Section Chairman in 1944-1945, and Organizing Chairman of the Upper New York State Section of A.S.E.E. in 1940.

The membership of I.E.S. has, in its 48th President, a man on the one hand distinguished in the more technical aspects of illuminating engineering, experienced in conducting society affairs, and who is at the same time a practical, warm individual, fully conversant with the ramifications of the lighting industry.

Views and Opinions

Opportunity Unlimited .... For Illuminating Engineers

AN IMPORTANT, job-potential branch of engineering is being overlooked by schools, colleges and universities. Hundreds of desirable careers in the lighting field are seeking men trained and ready to take them. Yet, Illumination as a subject of study finds itself neglected in the higher fields of learning.

THERE IS *opportunity unlimited* for trained illumination engineers. These opportunities lie in Residential, Commercial, Farm, Industrial, Highway and Municipal lighting, and numerous others.

IN RESIDENCE lighting, as an example, there remains a tremendous known need for planned quantity and quality lighting, at least 80 per cent greater than the present going rate of lighting usage in the homes of America. With not nearly enough illuminating engineers to do the job.

IN THE Highway and Municipal lighting fields the surface has barely been scratched. Thousands of miles of heavily-traveled highways remain unlighted from dusk to dawn. Graduate illuminating engineers could step right into jobs in this field.

PRODUCTION in our great industrial plants has been increased manifold with planned industrial lighting. But thousands of American industrial plants — more than half of them certainly — still are poorly lighted. A *real* opportunity is waiting for trained illuminating engineers in this field.

UP, DOWN and across our great nation there is a crying need from equipment manufacturers and electric utilities for men educated and trained in the fundamentals of illumination — to apply the better lighting needed everywhere for better health, safety, production, and living.

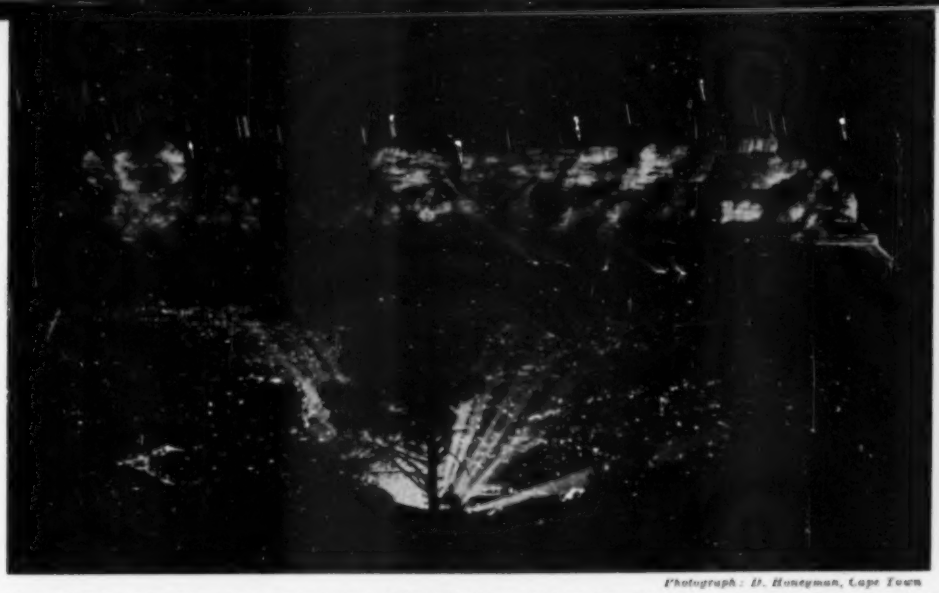
WITH THE dearth of men graduating as illuminating engineers from our educational institutions, companies requiring such personnel are faced with long-time training programs and added expense of thousands of dollars in the training, plus delay before such employees, previously untrained and uneducated in lighting principles, can become productive.

THE MAN who is trained and ready to step into this broad field of engineering finds OPPORTUNITIES UNLIMITED! For instance, in our company in 1946 we recognized the need for a number of qualified lighting men as full-time lighting consultants to serve the public and to train the residential, commercial, industrial and farm sales representatives in planned lighting fundamentals. There were none available from educational institutions. We selected likely candidates — trained them and put them into our service area divisions. They are happy and well-remunerated financially and in the satisfaction of accomplishment. Advancement has been steady. But what an opportunity this would have been for graduates in illumination!

YES! The lighting field is a wonderful opportunity! And — our institutions of higher learning have an opportunity . . . to inject into their curricula courses in illuminating engineering in order to bring to the front a new national consciousness of the vital importance of lighting in the mobilization of American industry for the national defense and in preservation of priceless eyesight for every American — while making possible for lighting engineers a new view of the ever-expanding Opportunity Horizon!

J. M. STEDMAN, *General Sales Manager*
Pennsylvania Power & Light Company
Allentown, Pennsylvania

For other comments on this subject, see ILLUMINATING ENGINEERING, June 1952, p. 395. ED.



Photograph: D. Honeyman, Cape Town

Figure 1. Table Mountain and Devil's Peak from Signal Hill behind Magazine. Clear day, prior to final adjustment of beams to Western Table.

Floodlighting Table Mountain

By H. D. EINHORN

The 20 million sq. ft. face of Table Mountain in South Africa was floodlighted by 51 military searchlights in April 1952. Although the luminance level attainable was low, a satisfactory effect was achieved by a careful choice of light directions. The design principles and some of the experience gained are discussed in this paper.

TABLE MOUNTAIN, towering above the City of Cape Town, South Africa, was floodlighted during the national tercentenary celebrations in April 1952. The scale of this floodlighting scheme was unusually large, the means employed presented problems of their own, and the design had to be based on preliminary experiments. Some rough luminance measurements at the end helped to analyze the results.

The experience gained is novel and might, therefore, aid others. This paper aims at recording features of general interest. Details of the scheme are given mainly to illustrate the underlying principles.

Scope of the Task

Table Mountain rises to a height of over 3,500 feet above Cape Town, which is practically at sea level. The mountain face is nearly 10,000 feet wide. Two flanking peaks on either side, Devil's Peak (3,300 ft.) and Lion's Head (2,200 ft.) form an integral part of the setting. Even if the floodlighting was concentrated only on the top rock sections, an area of over 20 million square feet had to be illuminated. This enormous area and the low reflectance of the medium gray sandstone (on the average between 30 and 40 per cent) seemed to ask for hundreds of millions of lumens if conventional brightness levels had been aimed at. The means available were 51 military searchlights which emitted a total flux in the order of five million lumens.

A rough calculation showed that an average level below 0.05 footlamberts in reasonably clear weather could be expected.

Assumptions: Number of searchlights — 51
Output per light — >100,000 lumens
(based on Reference 1)
Area — 20×10^6 sq. ft.
Reflectance of rock — 0.3
(based on sample tests)
Transmittance of atmosphere — <0.5
(based on Reference 2)
Hence:

$$\text{Luminance: } 51 \times 10^5 \times 0.3 \times \frac{0.5}{20 \times 10^6} \approx .04 \text{ ft-L}$$

AUTHOR: Lecturer in Electrical and Illuminating Engineering, University of Cape Town. He designed the lighting scheme discussed here. It was carried out under his guidance by the Defence Force of the Union of South Africa.

A "flat" lighting scheme as obtained from beams projected straight on the target was therefore liable to disappoint, particularly if environmental factors were taken into account, such as moonlight and the haze of a city gaily lighted for the celebrations. This calculation explains why a previous attempt at floodlighting Table Mountain (in 1947) by some 20 or 30 searchlights from Tamboers Kloof Magazine (see Fig. 3) resulted in an indifferent "flat" effect.

The principle adopted was, therefore, to bring out in relief the mountain features, buttresses, ridges and ravines, by directing the light beams predominantly from the side of the mountain face.

In addition to this main lighting (from Kloof Nek and Tafelberg Road) a moderate amount of perpendicular lighting was used (from Magazine) for relieving harsh shadows and marking out the skyline of the mountain sections not reached by the main light sources. By this combination a "plastic effect" was obtained.

Added advantages of this scheme were that (1) by concentrating the light on certain parts of the target area, leaving large shadow sections much darker, highlights well above the average could be obtained and (2) owing to the closer distance of the main lights, contrast was maintained in hazy weather.

Types of Searchlights Available

Two types of lights were available:

Type A — 150 cm mirror, 150 amp arc, fixed focus (Number available: 21)

Type B — 90 cm mirror, 150 amp arc, variable focus (Number available: 30)

It was appreciated from the outset that both types had to be used defocused. Most Type A lights were set at an angle of 7°, some at 5° or 4°. Most Type B lights were adjusted in the workshops to give the operators a range between 5° and 11°, a few were on a range of 3° to 9°.

Preliminary tests confirmed that the 150 cm lights, although of much higher candlepower rating, gave hardly more lumens and were therefore not superior to the 90 cm lights when defocused. In fact the latter had two advantages: the easy adjustability of the focus and the soft edge of the beam, which gave a smoother pattern when beams were placed next to each other.

Position and Design

The design of the lighting scheme was greatly limited by the sites available. Preliminary inspection showed that four positions might be suitable for accommodating a sufficient number of large searchlight trucks. Three of these were finally selected after some large-scale experiments with 20 lights, in October 1951, when different sections of the mountain were lighted on four different nights. The final layout is shown in Table I and Fig. 3.

TABLE I.—Design Lay-Out of Lights.

Target	Station	Number	Type	Beam Angle
Western Table	Kloof Nek	10	B	7°, 5°, 9°
	Tafelberg Rd.	2	B	11°
	Magazine	3	A	7°
Eastern Table	Tafelberg Rd.	16	B	6°, 8°
	Magazine	7	A	7°
Devil's Peak	Magazine	6	A	5°
	Kloof Nek	2	A	4°
	Tafelberg Rd.	1	B	5°
Lion's Head	Magazine	3	A	7°
	Tafelberg Rd.	1	B	6°

Western Table was lighted mainly from a battery of ten lights at Kloof Nek, backed up by three at the Magazine and two from Tafelberg Road to accentuate the two flanking ridges. Eastern Table was covered by sixteen lights along Tafelberg Road, supported by seven from the Magazine. Devil's Peak was mainly lighted by six lights from the Magazine, while two at the Nek and one on Tafelberg Road provided highlights near the summit. Lion's Head was lighted in a simple flat manner by four lights.

Design Procedure

Perspective sketches of the mountain as seen from the three different sites were made, and circles corresponding to the angle subtended by defocused searchlights were drawn in to determine the number of beams required and their approximate position. The beam-angles were limited on the one hand by the maximum defocusing possible, on the other hand by the number of lights available.

Between these limits the actual angles were so determined as to give a brightness balance considered desirable from an artistic point of view. Each circle on the design sketches was numbered and allocated to a definite searchlight, which was sighted during the day (see, as example, Fig. 4 for Eastern Table). In some cases two beams were superimposed on the same target section, mainly to emphasize the top edge of the mountain.

The daytime setting was only provisional and approximate; the final direction-fixing prior to clamping was carried out at night by radio-control from the "control" position on the roof of a city building (see Fig. 3).

Methods of Directing Beams

The exact aiming of beams and the identification of a misplaced one among a score of others is by no means easy. It is well known that an operator behind a light has difficulty in ascertaining the exact direction of his beam. The general design could only be observed from the central "control" position and instructions given by radio-telephony.

Photograph: Epon Fischel, Cape Town

Figure 2. Devil's Peak, Table Mountain and Lion's Head from harbor. Hazy day with low clouds.

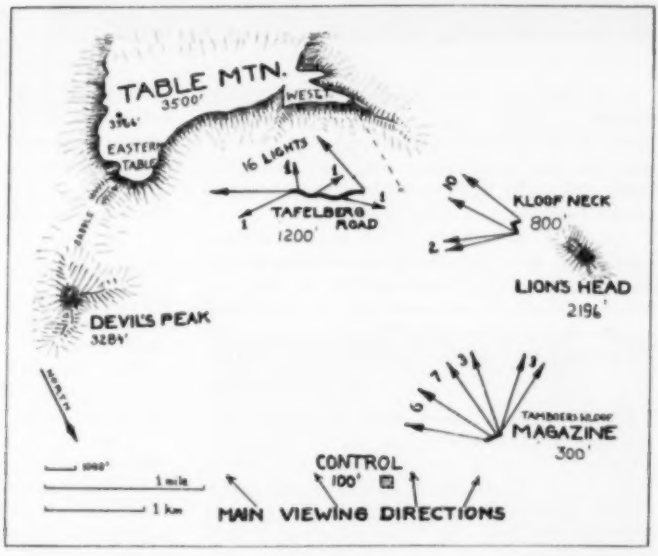


Figure 3. Layout showing placement of lamps.

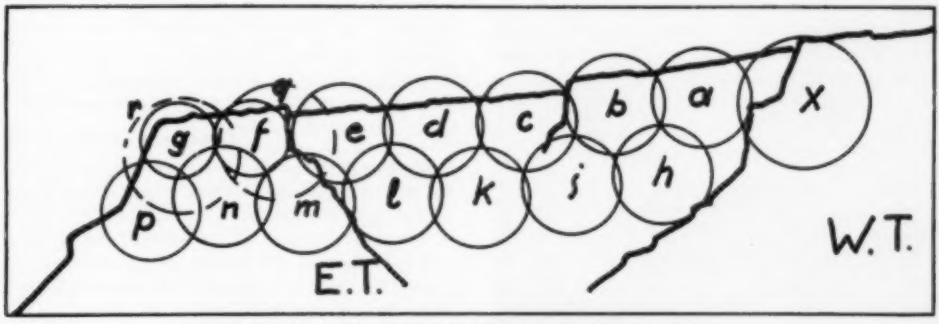


Figure 4. Design for beams from Tafelberg Road to Eastern Table.

Figure 5. Searchlights on Tafelberg Road with Devil's Peak in background.

Photograph: Author

Two stratagems were found very useful: firstly, to focus a light to a thin beam before setting, and opening it to the required wide focus only after the direction was fixed; and secondly, to switch off a light, considered misplaced, and expose it again after a few seconds in order to identify it.

The use of color filters in the form of theater color media or transparent paint was tried briefly, but apart from artistic considerations the effect was not considered commensurate with the additional expense and technical difficulties due to heating and loss of light.

Final Production

Based on the experience gained during the October tests, the final tableau was "produced" in one single evening. The fifty beams were placed in about five hours, with the aid of eight radio-communication posts. Some minor readjustments were made two days later. Fig. 1 was taken from a position above the Magazine, to the right of the control point. Fig. 2 shows all three mountains from the harbor, a position more distant than the control point and farther left. It was taken on a hazy night, probably the same night when the second set of luminance measurements in Table III were taken.

TABLE II.—Cost Data.

	Fuel Consumption (Imperial Gallons)*	Carbons Used (Pos. + Neg.)
Experiments (Oct. 51); Training; Transport.		
Setting up (March 52)	1490	1240
Operation for 6 nights (April 52)	1740	2160
Total	3230	3400

*One Imperial gallon = 4.54 liters = 1.2 U. S. gallons.

The floodlighting was then carried on for a week, from 8 P.M. to 10 P.M. every evening, with a five-minute interruption every half hour, for changing carbons. These interruptions added to the dramatic effect and are considered preferable to a sporadic turning off of individual lights.

Cost

Manpower.—About 130 officers and men, including operators, technical maintenance staff and signal personnel were employed during the final production.

Fuel, Carbons, Etc.—Over 3,200 gallons (Imperial) of gasoline were used, mainly to run the engine-generators, partly for transport (Table II). At a cost of 2/6 (about 35c) per gallon the fuel expenditure amounted to £400 (about $1,120).

The 3,400 carbons used were at a cost of just over £200 ($560). In addition about £200 were spent on repairs and overhauling. Hence the total cost excluding wages amounted to just over £800. ($2,000).

Specific Costs.—The average fuel consumption per light was three gallons per hour. Considering that the illuminated mountain was seen, and presumably enjoyed, by at least half a million people the cost per spectator was well below a halfpenny.

Luminance Measurements

Rough luminance measurements were taken from the roof of a building (marked "control" in Fig. 3) on two different nights.

The results (Table III) confirmed the expectation that the level of brightness achieved was much lower than that recommended and usually obtained when floodlighting buildings.

Atmospheric conditions affected considerably

TABLE III.—Luminance Measurements.

	Approximate Footlamberts	
	Clear night	Slightly hazy night
Bright sections and highlights	0.1 - 0.13	0.03 - 0.04
Medium bright sections		0.01 - 0.02
Shadow sections	0.007	
Surround (lower slopes, not lighted)	0.002	
Searchlight beams		0.2 - 0.5

NOTE: A visual low-level luminance-meter, built by Mr. Hynd, was used. The measurements were taken rapidly by a single observer to establish the order of magnitude. Great accuracy is not claimed.

both the luminance and the artistic effect obtained. The famous "tablecloth," a heavy cloud frequently appearing along the top edge of the mountain was rather an asset on one night. Lower clouds and fine haze on another night impaired the effect.

Conclusions

The illumination of Table Mountain was favorably received by press and public. The result justifies the general conclusion that floodlighting at a low luminance-level (of the order of 0.1 footlambert, or even less) can be effective, provided:

(1) the target itself is large and sufficiently picturesque,
(2) its plastic features are brought out and dramatized by a choice of careful light direction.

In this case the pattern obtained from round beams does not disturb the artistic effect appreciably.

While light beams controlled by specular reflectors or lenses are needed for floodlighting from a distance greater than the target width, reflectors much smaller than those used at Cape Town would be quite adequate, since it is the total lumens that matter rather than the candlepower. Although thin beams of high intensity as obtained from large focused reflectors would permit greater distance between light and target, atmospheric absorption is then likely to reduce the efficiency severely and limit the practical range.

The high cost of a project of this type and the necessity of "producing" in front of the public calls for meticulous planning and warrants the appreciable time which has to be spent on design and organization.

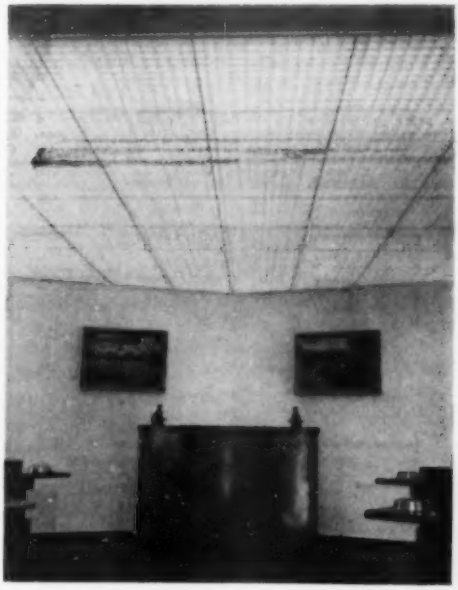
The author acknowledges the efficiency and cooperative spirit of the officers and men of the South African Defense Force who made this great floodlighting scheme a success.

References

1. Symposium on Searchlights, Illuminating Engineering Society (London), p. 15 (1948).
2. I.E.S. Lighting Handbook, First Edition, Illuminating Engineering Society (American), Table 13-2; Second Edition, Table 15-2.

Louverall Ceiling In Branch Ticket Office

The 700 sq. ft. of this branch ticket office of the Union Pacific Railroad Co. in Beverly Hills, Calif., are lighted primarily by the louverall ceiling, 4-foot panels of 2 x 2 x 2-inch cells. The panels are mounted 8 feet from the floor and 18 inches below the lamps. Continuous rows of 48-inch preheat fluorescent lamps are mounted on 18-inch centers. Standard cool white lamps are used except in the border rows, which use pink lamps to accentuate the effect of the coral sandstone masonry. Maintained lighting levels are from 65 to 70 footcandles. Architect is J. T. Beem, A.I.A. Data submitted by Illuminating Engineering Unit, Department of Water and Power, City of Los Angeles. ***Photo by Union Pacific Railroad Co.***



A New Lead-Lag Ballast For Discharge Lamps

By C. H. BURNS
H. E. BACHMAN

FOR A NUMBER of years the lead-lag circuit as shown in Fig. 1 has been used in practically all two-lamp fluorescent ballasts.

In the last few years several new two-lamp circuits have been used for fluorescent lamp ballasts. These circuits are similar in that all operate the two lamps in series and the lamps start in sequence. Hence, the general designation is series sequence-start ballast.

The series sequence-start circuit, in any of the presently used forms, has a number of advantages over the conventional lead-lag instant-start ballast, which may be summed up as follows:

1. Lower losses.
2. Smaller size and less weight.
3. Lower cost.

The series sequence-start circuit, however, also has a number of disadvantages as listed below:

1. No stroboscopic correction, since the lamps operate in series.
2. Failure of one lamp causes the other lamp to either go out or operate at very low current.
3. Premature failure of lamp operating at low current for extended periods of time and low starting current causes a reduction in lamp life.
4. Lamp maintenance education is very difficult.
5. Lamps are unstable at low temperatures.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHORS: Engineering Section Manager, Ballast Section, Westinghouse Electric Corporation, Cleveland, Ohio, and Engineering Section Manager, Lamp Engineering, Westinghouse Electric Corporation, Bloomfield, N. J.

Lamp Behavior

Hinman, Keiffer and Strecker[1] have shown how fluorescent lamps go through two transitions in starting: first, the vapor in the lamp must be ionized sufficiently to conduct current; second, the cathode drop must be decreased from its high value when the cathodes are cold to the low value of normal operation with the cathodes hot. The length of time necessary to pass through this second period is dependent on the amount of energy supplied by the ballast. In general, if the lamp remains in this second period for any length of time the life of the lamp will be shortened.

The conventional lead-lag circuit provides sufficient open-circuit voltage and energy to carry the lamps through the starting phases to normal operation in a very few cycles. In the first types of series sequence-start ballasts manufactured, the current through the lamps was low during starting and the transition through the starting phases took as long as several seconds.

After considerable trouble was experienced in the field with this type of ballast, most manufacturers modified their designs to provide higher current during the starting phases, thus shortening the transition period. However, the starting current was still much lower than with the lead-lag ballast. Therefore, the transition period still required more time than with the lead-lag ballast and lamp life was somewhat reduced as compared to the lead-lag circuit.

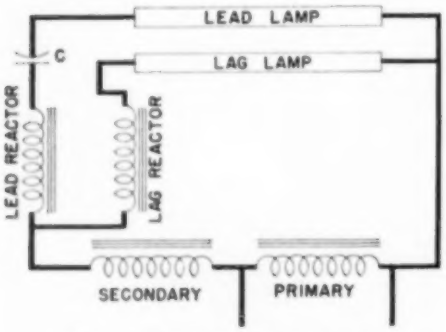


Figure 1. Conventional lead-lag circuit.

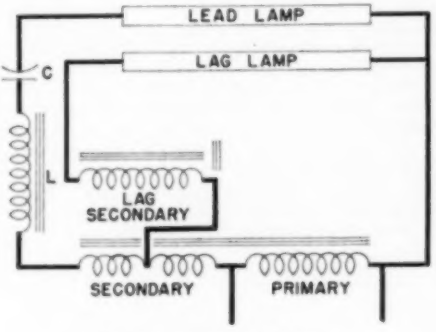


Figure 2. New lead-lag circuit.

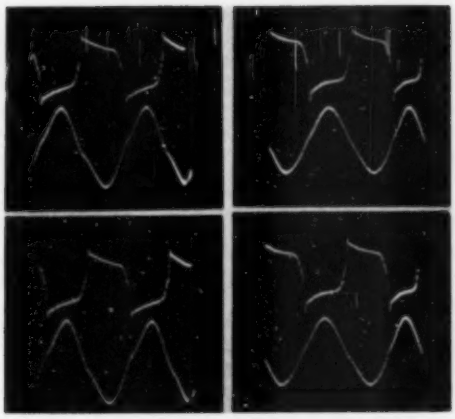


Figure 3. Lamp current and voltage on new lead-lag circuit. Upper left—lead lamp (lag lamp operating). Upper right—lag lamp (lead lamp operating). Lower left—lead lamp (lag lamp out). Lower right—lag lamp (lead lamp out).

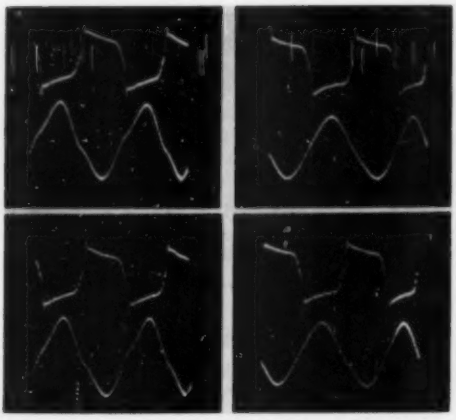


Figure 4. Lamp current and voltage on conventional lead-lag circuit. Upper left—lead lamp (lag lamp operating). Upper right—lag lamp (lead lamp operating). Lower left—lead lamp (lag lamp out). Lower right—lag lamp (lead lamp out).

Circuit Description

The circuit described and discussed in this paper is basically the familiar lead-lag circuit. To simplify our descriptions and discussion of operation, we will limit the discussions to the 96T12 425 ma ballast since a similar circuit is used and similar results are obtained when this basic design is used with other ratings of lamps and other current loadings. The basic circuit for this rating is shown in Fig. 2.

The lead circuit utilizes an auto-transformer with low reactance to supply the necessary open circuit voltage. This reactor-capacitor combination is predominantly capacitive and limits the current through the lead lamp to the proper value of 425 milliamps.

The lag leg of the ballast utilizes a portion of the auto-transformer which supplies open circuit voltage to the lead lamp. The lag winding is a high reactance secondary winding which is tapped off the low reactance auto-transformer winding. The vector sum of the voltages across these windings provides the required open circuit voltage for the lag lamp. Since this lag winding is loosely coupled to the auto-transformer it also limits the lag lamp current to the proper value.

With this circuit the auto-transformer section of the ballast can be operated at a relatively high flux density and copper loading, thus resulting in considerable savings in copper and iron. In the conventional lead-lag circuit shown in Fig. 1 the auto-transformer section will operate at relatively low currents on normal operation but the currents will increase under abnormal operation when one lamp is out. Consequently the total losses in the auto-transformer section on the conventional lead-lag ballast are higher under the abnormal condition of operation than in normal operation with both lamps burning. The maximum temperature and losses with the conventional circuit exist when the lag lamp is operating and the lead lamp is open.

In the new circuit shown in Fig. 2, during abnormal operation with the lead lamp out and the lag lamp operating, approximately half of the auto-transformer coil secondary is out of the circuit thus reducing the copper losses to zero in this particular section. This partially compensates for the increased current in the remainder of the auto-transformer coil and the auto-transformer coil losses are somewhat higher than for normal operation. When the lag lamp is out and lead lamp operating, the magnetizing current of the auto-transformer coil opposes the leading current of the lead circuit and thus keeps the resultant current to a relatively low value. The operation of the auto coil at a relatively high density causes high magnetizing current which becomes an advantage where the lag lamp is out. The auto-transformer coil on this ballast is so designed to take advantage of these conditions by proper arrangement of the various sections of the winding to provide the lowest total losses under any condition of operation. The coils are likewise arranged on the core structure to provide the lowest possible temperature rise under all conditions of operation.

The lag coil on this new circuit can be approxi-

mately one-half the size of the lag reactor coil used with the conventional circuit shown in Fig. 1 since this coil serves a dual purpose, acting as an autotransformer secondary as well as a current limiting reactance for the lag lamp. This results in a much lower voltage drop across this coil during operation than with the conventional lag reactor and consequently a lower volt-ampere rating.

Because of these factors, discussed above, the total loss on this ballast is approximately 35 watts as compared to a loss of 45 watts in the conventional lead-lag ballast.

Steady State Operation

The oscillograms shown in Fig. 3, taken with the new circuit, illustrate the current and voltage wave forms under both the normal and abnormal conditions of operation. The upper trace is lamp voltage and the lower trace represents lamp current. (In order to show both voltage and current simultaneously the output of a square wave generator was fed into the oscilloscope and the lamp voltage and current signals superimposed on the upper and lower half, respectively, of the square wave. The variations in intensity of the traces and the faint pips seen in the background on some of the oscillograms are produced by the square wave and its distortion and are not generated by the ballast or lamps.) A comparison of these curves with the one shown in Fig. 4 taken with the conventional circuit of Fig. 1 show the wave shape is approximately the same. Both lead and lag currents are very close to sine waves and have a very low peak to R.M.S. ratio.

Since this new circuit is lead-lag, the stroboscopic correction is identical with that of the conventional lead-lag circuit, whereas the series type ballasts provide no correction since the lamp currents are in phase.

Table I shows the values of current obtained under the various operating conditions, when checked with a resistor load as specified in the suggested supplement to the proposed ballast specification ASA C82.1.[2] From this table it can be seen that the starting currents under all conditions are

TABLE I.—Current Through Resistor per Proposed Specification Supplement.

LEAD-LAG BALLASTS

		Current with Resistor in Lead-Lamp Position		Current with Resistor in Lag-Lamp Position	
	Line Voltage	Without Lamp in Other Position	With Normal Lamp in Other Position	Without Lamp in Other Position	With Normal Lamp in Other Position
Conventional Lead-Lag	106	135	130	135	130
	118	149	145	150	146
New Lead-Lag Circuit	106	133	130	135	130
	118	149	145	148	145

SERIES SEQUENCE-START BALLASTS

		Current with Resistor in #1 Lamp Position		Current with Resistor in #2 Lamp Position	
Ballast	Line Voltage	Without Lamp in #2 Position	With Normal Lamp in #2 Position	Without Lamp in #1 Position	With Normal Lamp in #1 Position
A	106	56	108	0	94
	118	62	126	0	107
B	106	26	90	107	94
	118	29	107	118	103
C	106	93	112	115	102
	118	36	131	128	112
D	106	50	99	0	104
	118	57	113	0	117
E	106	26	110	119	104
	118	31	120	133	117

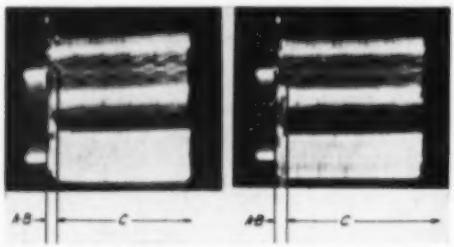


Figure 5. Lamp current and voltage during the starting phases with the new lead-lag circuit (new lamps). Left—lag lamp. Right—lead lamp.

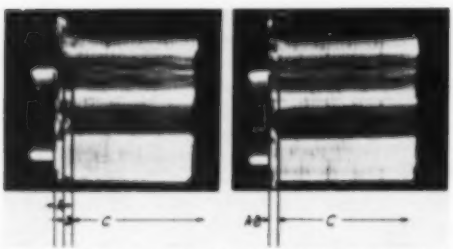


Figure 6. Lamp current and voltage during the starting phases with the conventional lead-lag circuit (new lamps). Left—lag lamp. Right—lead lamp.

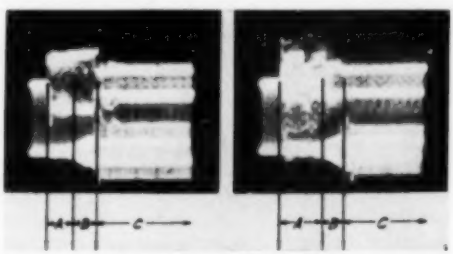


Figure 7. Lamp current and voltage during the starting phases with the series sequence start circuit (new lamps). Left—Lamp No. 1. Right—Lamp No. 2.

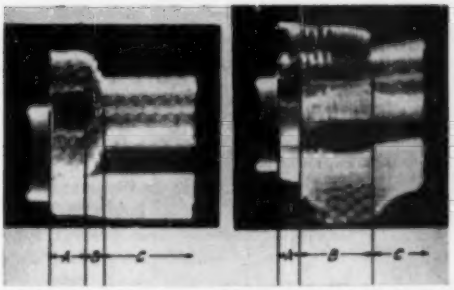


Figure 8. Lamp current and voltage during the starting phases with the new lead-lag circuit (lamps near end of life). Left—lead lamp. Right—lag lamp.

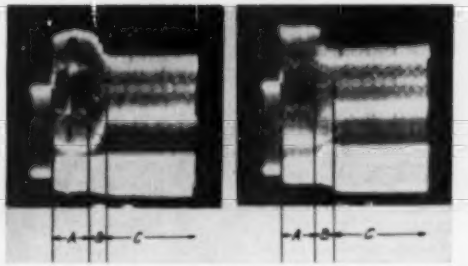


Figure 9. Lamp current and voltage during the starting phases with the conventional lead-lag circuit (lamps near end of life). Left—lead lamp. Right—lag lamp.

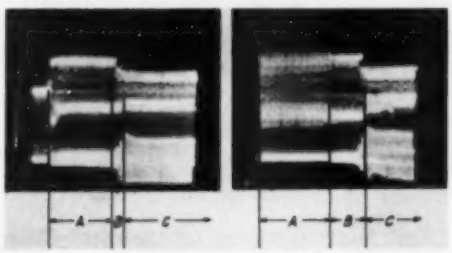


Figure 10. Lamp current and voltage during the starting phases with the series sequence start circuit (lamps near end of life). Left—Lamp No. 2. Right—Lamp No. 1.

considerably higher than with the series sequence-start ballast and are almost identical with the conventional lead-lag circuit. Thus the operation of this circuit will be conducive to long lamp life since this high starting current will cause the lamps to pass through the starting phase in a very few cycles, as discussed below.

Operation During Starting Phases

Figs. 5, 6 and 7 show oscillograms of lamp current (lower trace) and voltage (upper trace)during the starting phases, with two good lamps in the circuit. These oscillograms compare operation on the new circuit, Fig. 5, with the operation on the conventional lead-lag circuit, Fig. 6, and series sequence-start circuit, Fig. 7. In all oscillograms the upper trace is lamp voltage and the lower trace is lamp current. The number of cycles required to pass through the starting phases is indicated on the oscillograms. Phase "A" is the period when both cathodes are cold. Phase "B" covers the period of operation with one cathode cold and one cathode hot. Phase "C" is normal operation with both cathodes hot.[1] It can be seen that the time required to pass through the starting phases is considerably less with either type of lead-lag circuit than with the series circuit.

Operation With Lamps Near End of Life

Figs. 8. 9 and 10 are oscillograms of lamp current (lower trace) and voltage (upper trace) taken during the starting phases with lamps which are nearing the end of their lives, operating on the new circuit, the conventional lead-lag circuit, and the series sequence-start circuit, respectively. Here again, Phases "A," "B" and "C" are marked as explained above. These oscillograms show that some rectification occurs on the lag circuits of lead-lag ballasts when one cathode of the lamp has lost most of its emission material. Because of the operation of the iron at a higher flux density in the new circuit, the rectification on the lag lamp in this circuit is somewhat greater than the conventional lead-lag ballast. However, numerous tests have indicated that this rectification condition usually occurs only with lamps near the end of their life, that is, within a few hours of the end of their life, and consequently has little effect on the total life of the lamp. A lamp operating in this condition normally fails so rapidly that the increased lamp current will not cause damage to the ballast since the lamp fails before this increased current can over-heat the ballast.

Life Test Data

The standard cycle test of three hours on and 20 minutes off, shown in Table II covered tests on the new circuit and on the conventional lead-lag circuit. These data indicate that lamp life with the new circuit will be comparable to that with the conventional lead-lag circuit. These tests are not complete and these values are expected to increase since lamps are still burning on the new circuit. Further tests are also being conducted to give more complete data.

Extensive tests on two different shorter cycles show similar results. These data also indicate that lamp life with the new circuit approximates life with the conventional lead-lag ballast.

TABLE II—Standard Cycle Test.
3 Hours On, 20 Minutes Off.

	NEW LEAD-LAG BALLAST		CONVENTIONAL LEAD-LAG BALLAST	
	Number of Lamps	Per Cent of Life on Conventional Ballast**	Number of Lamps	Per Cent of Average Life**
Lag Side ...	6*	90*	2*	100*
Lead Side .	5*	101*	3	100
Total	11		5	
Average		98		100

*One lamp still burning.
**Average life on conventional lead-lag ballast taken as 100%.

TABLE III—Standard Cycle Test.
3 Hours On, 20 Minutes Off.

	SERIES SEQUENCE START BALLAST			CONVENTIONAL LEAD-LAG BALLAST	
	Number of Lamps	Per Cent of Life on Conventional Ballast*		Number of Lamps	Per Cent of Average Life*
#1 Lamp Side	6	70	Lag Side ...	6	109
#2 Lamp Side	6	64	Lead Side .	6	91
Total	12			12	
Average		67			100

*Average life on conventional lead-lag ballast taken as 100%.

Table III covers standard cycle tests (three hours on and 20 minutes off) on the series sequence-start ballast versus the conventional lead-lag ballasts. Comparison of these data with the data shown in Table II indicates that lamp life on the new lead-lag circuit is definitely greater than on the series ballast.

Summary

This new ballast circuit described above offers practically all of the advantages and none of the disadvantages of the existing circuits. From the analysis and from designs made up to date, it appears to be applicable for use with practically all of the slimline lamps as well as with certain of the preheat type lamps. It has been used to date on the 48T12, 72T12 and 96T12 slimline lamps operating at 425 milliamps and the 90-watt preheat type lamp. It has the characteristic lead-lag advantages of stroboscopic correction, plus rapid transition through the starting phase, and good wave shape which insure long lamp life. It also has the advantages of the series sequence-start ballasts in that it is smaller in size in certain ratings, has less weight and lower losses and also lower cost than the conventional lead-lag ballast. It entirely eliminates the most serious disadvantage of the series sequence-start ballasts; namely, maintenance problems due to both lamps either going out or one glowing only faintly when one lamp fails, which results in loss of light output or in some cases the replacement of a good lamp. It is felt that this circuit can in most applications offer all the advantages and none of the disadvantages of existing ballast circuits.

References

1. Hinman, D. D., Keiffer, R. L., and Strecker, C. E.: "Fluorescent Lamp Performance on Sequence-Start Ballasts," ILLUMINATING ENGINEERING, Vol. XLVI, p. 560 (1951).

2. Proposed American Standard Specification for Fluorescent Lamp Ballasts, C82.1.

Symbolic Design Used In Louvered Lighting Element

Symbolism and light are blended for functional and inspirational purposes in this design. The ancient Star of David suggested the outline of the louvered element in the stairwell of the Kingsway Jewish Center, Brooklyn, New York.

The element contains ten 96T12 cool white slimline lamps. It is faced by the Star, which is 9 feet wide between opposite points. The louver consists of 3-inch cubed cells, finished in white enamel. Soft modeling accents and shadows are obtained by four recessed units containing 150-watt R-40 reflector flood lamps. A minimum of 15 footcandles is produced on the landings and stair treads. Floor surfaces are tan terrazzo, walls are gray and the ceiling is green. ***Photo courtesy of General Electric Co., Cleveland.***

Coordination of Lighting With Architectural Design

ELEMENTS of the lighting design have been coordinated completely with the architectural features in the banking room shown above, for an exceptionally pleasing interior. The installation is in the new building of the Lancaster (New York) Branch of Manufacturers and Traders Trust Company of Buffalo.

Cold cathode custom-built lighting is used in the troffer system installed over the working areas. These are 24 inches wide, five feet on centers and carry six rows of 25mm white tubing. For complete diffusion, the cover glass is satin finished. The glass is in four-foot lengths with butting edges ground to eliminate light leaks. The lamps are in unit lengths approximately seven feet three inches long, with cathodes installed at right angles so that in rows they can be placed end to end with no dark space showing on the diffusing glass.

The tubes, switched to give three levels of illumination, are operated at approximately 100 ma on transformers with ratings 6000 to 12,000 volts and 120 ma short circuit current. Access to the transformers is through removable plates in the sides of the troffer enclosure.

In the working areas, 60 footcandles minimum were measured after six months of operation.

The customer area is lighted by coffers twenty inches deep, illuminated by coves carrying two rows of 25 mm tubing around the periphery. This tubing is also in standard lengths except for the corners where bends are made to provide completely even lighting of the hard plaster reflecting surface. The excellent design of the coffers is indicated by the even illumination with no highlights or shadows and the good amount of light on the acoustical plaster center section. A subtle and interesting color difference is obtained in the coffers by using 4500K white tubing. Thirty-five footcandles are provided 30 inches above the floor and directly under the center of the coffer. On the customer check counters, additional illumination is provided by troffers in the overhead pattern.

Colors of the surfaces have also been carefully coordinated with the design, to aid in creating an efficient, comfortable and modern appearance. Walls are finished in burgundy, with the ceiling an off-white acoustical tile. Colorful draperies and light colors in the terrazo floor complete an interesting color pattern.

The installation was designed by Duane Lyman & Associates, Architects, Buffalo, with assists from the Eastern Sign Co., who installed it.

This installation was third-place winner in the contest conducted by the Western New York Section of I.E.S. for "My Most Interesting Lighting Job," and was presented by Neal Jacobus, Sylvania Electric Products Inc., Buffalo, New York.

Photo courtesy of Sylvania Electric Products Inc.

Classroom Lighting: A Practical Comparison

By R. D. BRADLEY

TO ANSWER a long felt need for data on the characteristics of practical classroom lighting and the changes which take place in these characteristics over a period of time, a study was started in seven rooms of the North Glendale School, Glendale, Missouri, in 1948. Using standard lighting techniques and layouts in combination with commercially available equipment, the program was designed with maximum emphasis on illumination quality. However because of their importance in the school lighting field, the quantity of light and the cost of lighting were included in the comparisons to be made.

The type of lighting and the arrangement of the luminaires in each of the classrooms are shown in Fig. 1. The lighting installations shown in rooms A (Fig. 2) and B (Fig. 3) existed in the school at the start of the study and no installation cost data were available. Room C (Fig. 4) was lighted with six four-lamp fluorescent fixtures, room D (Fig. 5) with two continuous rows of two-lamp fluorescent units, room E (Fig. 6) with three continuous rows of two-lamp units, and rooms F (Fig. 7) and F-45 (Fig. 8) with continuous rows of two-lamp fluorescent fixtures in a U-shaped layout. Room F-45 differed from room F in that the luminaires were shielded to 45 degrees longitudinally and were on 16-inch hangers rather than 8½-inch. All fluorescent luminaires were equipped with cross louvers and had opaque side panels except for those in room E which had luminous side panels.

All rooms were uniformly redecorated to conform to the American Standard Practice of School Lighting recommendations. Blonde school furniture was installed.

The following comments are based on data taken during the time which has elapsed since the study was instituted. For quick comparison and reference, these data are presented in Table I.

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Quality Comparisons

In determining the quality of the illumination provided, the criteria included: (1) the uniformity of the illumination, (2) the brightness ratios, (3) the chalkboard illumination provided by the lighting system, and (4) the glare, as appraised by the Glare Factor method.

In determining the uniformity of illumination, the lowest footcandle level found in the seating area was compared with the highest level. All measurements were made with a color-corrected two-cell Weston light meter, and readings were taken at the desk top level after the installations had aged 100 hours.

On the basis of these measurements, room D showed the most uniform distribution, with a low-to-high ratio of 1:1.38. Rooms C and F rated next, and the others followed in the order: F-45, B, E, and A. It was noted that the lowest level of illumination was universally found to be on the row of desks at the rear of the room. This suggested a statistical comparison of the last row footcandles to the mean footcandle level in each room. Room D again topped the others, this time with a last row lighting level which was 92 per cent of the mean.

TABLE I.

NIGHT READINGS	Room A	Room B	Room C	Room D	Room E	Room F	Room F-45
Footcandle Average (ASPSL Rec. 30 min.)	11	6	34	25	49	48	47
Footcandle Uniformity	1:1.87	1:1.90	1:1.65	1:1.39	1:1.81	1:1.65	1:1.70
Last Row Ftc in % of Mean	40%	45%	57%	92%	66%	83%	81%
Task :Desk (ASPSL Rec. 1:3)	1:5.5	1:4.6	1:1.15	1:1.6	1:1.32	1:1.98	1:1.10
Task :Floor (ASPSL Rec. 1:10)	1:2.35	1:2.4	1:5.0	1:3.43	1:5.15	1:3.4	1:3.4
Task :Ceiling (ASPSL Rec. 1:10)	1:10.0	1:13.7	1:3.82	1:4.37	1:2.80	1:4.5	1:3.2
Luminaire :Ceiling (ASPSL Rec. 1:20)	1:12.0	1:2.45	1:4.96	1:1.79	1:2.32	1:1.23	1:2.4
Luminaire :Front Chalkboard	1:1800	1:240	1:154	1:34	1:54	1:60	1:64
Average Ftc Front Chalkboard	5	3	18	22	36	40	36
Installed Wattage	1200	1200	1146	1337	1719	1392**	1392**
*Installation Man Hours			8.5	13.5	23.4	11.0	11.0
***Installed Cost to School			$278.00	$373.66	$510.50	$473.35	$519.11
Glare Rating (Harrison Meaker)	82Lx66C	8Lx7C	24Lx20C	12Lx11C	8Lx11C	13Lx12C	9Lx12C

*Roughing in time not included.
**Series Sequence Ballasts.
***Includes 10% contractor profit, lamps and labor @ $3.55/hour.

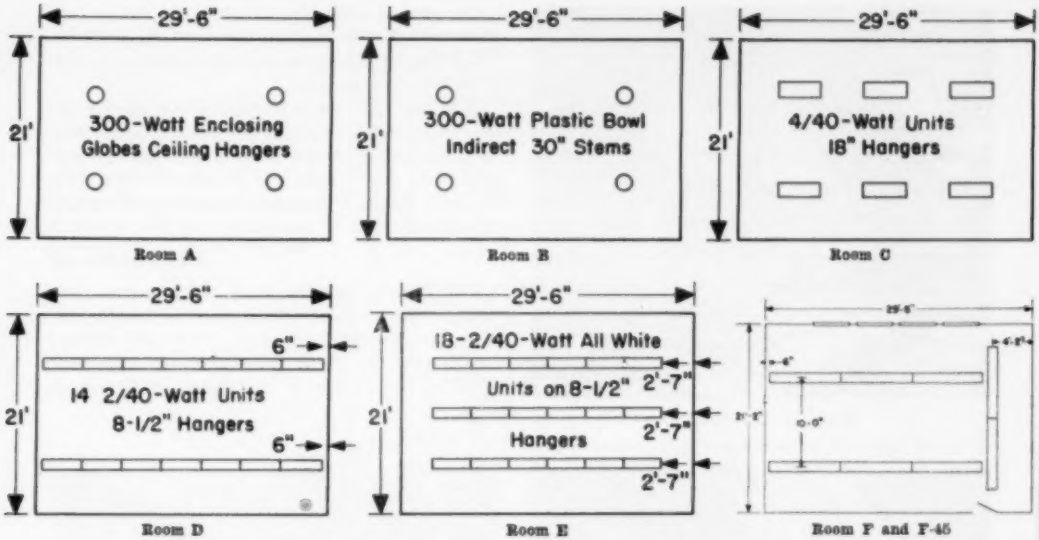


Figure 1. Layouts of the seven classrooms studied.

Percentages in the other rooms were: A—40 per cent, B—45 per cent, C—57 per cent, E—66 per cent, F—83 per cent, and F-45—81 per cent. Additional investigation proved that the footcandles on the last row of desks fall off sharply as the distance between the end of the fixture row and the wall is increased. This relationship is shown in Fig. 9.

Brightness ratios in all rooms were well within the American Standard Practice recommendations. In this Glendale study, one brightness ratio has been added to those covered by the A.S.P.S.L. recommendations: the ratio of the brightness of the front chalkboard to the brightness of the luminaire. Although these are not adjacent brightnesses, both are in the students' view most of the time. While there are no established recommendations for this ratio, it seems probable that a value of 1:40 is desirable and 1:60 may not be excessive. A lighting system can help keep this ratio low by incorporating low luminaire brightness with high footcandle distribution on the chalkboard.

Room F is outstanding in this comparison because of its relatively low brightness ratio (fixture:

Figure 2. Classroom A.

Figure 3. Classroom B.

Figure 4. Classroom C.

chalkboard) and the high illumination provided on the board (40 footcandles). Rooms D, E, and F-45 follow closely in this respect, but rooms A, B, and C are greatly inferior.

It is true that the reflectance of the surface of the chalkboard has a major effect on this brightness ratio, but this is beyond the control of the lighting system. In these rooms, boards were refinished with Vismatic Green, a matt surface with a reflectance of approximately 10 per cent.

Glare Calculated

The Harrison-Meaker glare rating system was used to evaluate each of these lighting installations from the standpoint of glare. With this system, the greater the glare, the higher the numerical value of the rating. A correlation of numerical

Figure 5. Classroom D.

Figure 6. Classroom E.

Figure 7. Classroom F.

Figure 8. Classroom F-45.

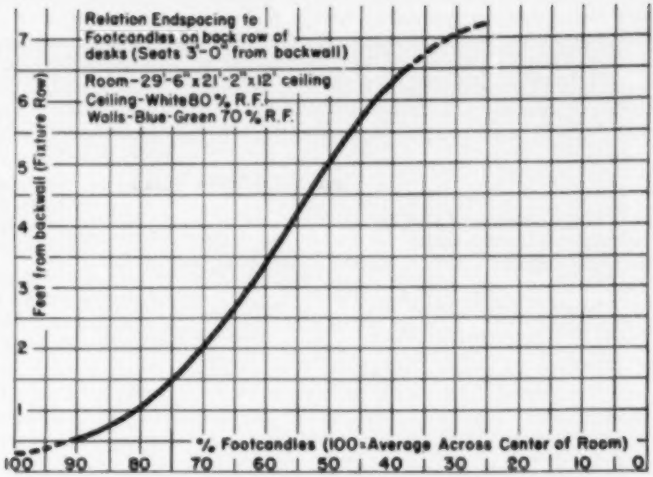


Figure 9. Relationship between footcandle level and the distance between end of fixture row and wall.

values with the visual sensations actually experienced is shown in Fig. 10.

Since the students' view of the room is generally lengthwise, the lengthwise glare factor tells the major story. Thus, rooms B and E, with factors of 8, and room F-45, with a factor of 9, are the most comfortable. The others follow in the order: D, F, C, and A. The fact that room B, with an illumination level of only six footcandles, rates in the "comfortable for all" category emphasizes that a low glare factor is strictly an indication of comfortable visual surroundings and in no way insures adequate illumination for the satisfactory performance of the visual task.

By comparing the glare factor for room F-45 with those of rooms D or E, it can be seen that a

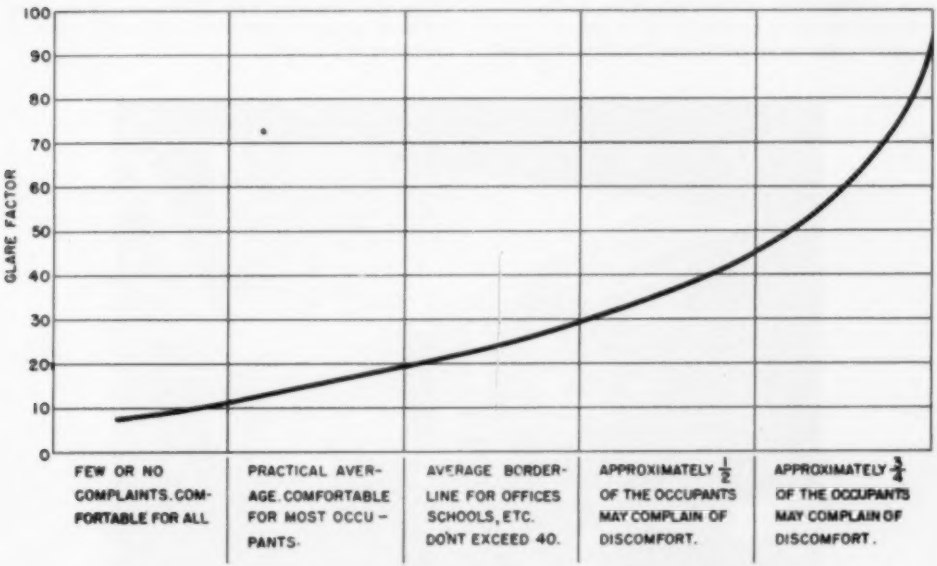


Figure 10. Glare factor evaluation. A correlation of numerical values with visual sensations actually experienced.

low factor does not necessarily require 45-degree shielding. However, the extra shielding of the units in F-45 does seem to provide some glare improvement over those used in room F. It is interesting to note that room A actually falls in the area of "discomfort" on the chart in Fig. 10.

Conclusions

This is a continuing study of classroom lighting installations under actual conditions and much more information will be accumulated and assimilated as these rooms see more service. Nevertheless, certain conclusions can be drawn from the facts which have been reported above.

(1) Since the students in the rear row of desks have the poorest visual conditions in the room, i.e. most window glare, most glare from the lighting system, and the greatest distance from the front chalkboard, it is felt that poor lighting distribution on the last row of seats should be improved by extending continuous row lighting equipment as far as possible toward the back of the room.

(2) During the planning of a lighting installation, every effort should be made to provide adequate lighting on the chalkboard, for the combined purposes of providing additional visibility and reducing the chalkboard-to-luminaire brightness ratio.

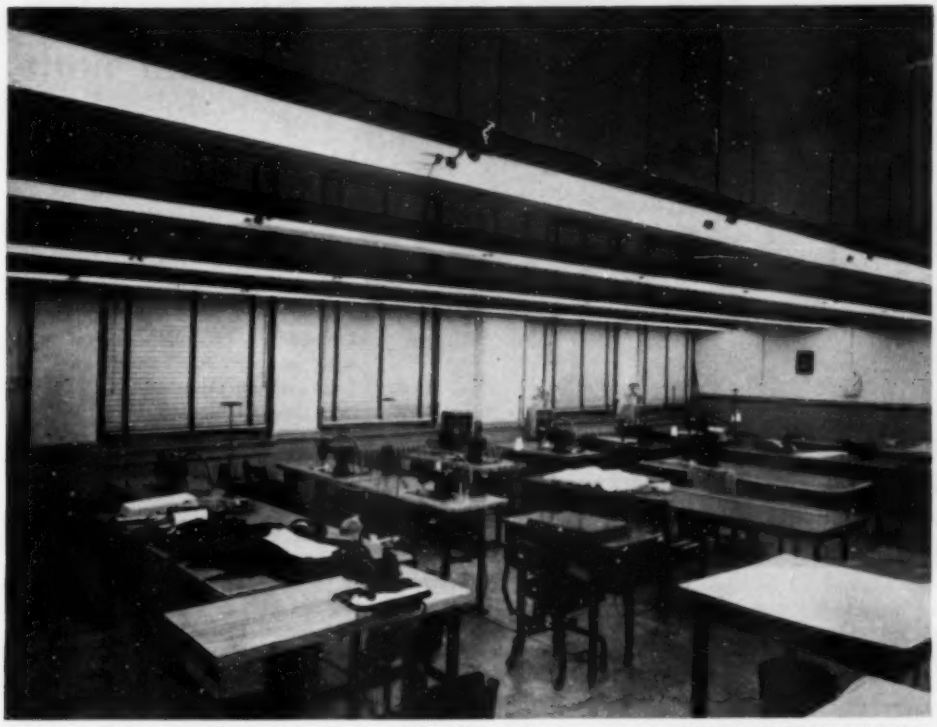
(3) The visual comfort of the students is of equal importance to the amount of light to be provided. The quality of illumination should be such that glare ratings of 20 or below are maintained.

(4) Because cost is an important factor in school lighting, and because classroom installations remain in use from 20 to 30 years, the lighting designer must use all available knowledge to produce comfortable and adequate seeing conditions, without unnecessary expenditure, for the children of tomorrow.

Cold-Cathode Lighting for Glass Counter

A soft lighting effect with about 30 footcandles was considered desirable for this Chicago salon of Helena Rubinstein, Inc. To light the 10-foot-long counter, 25 mm 4500K white bent cold cathode tubes are installed in a specially designed parabola reflector. Two tubes are used with a double lamp holder in the center. The 120 ma ballasts are located under the rear ends of the counter.

General lighting is provided by three rows of 40-watt fluorescent lamps with lamp holders staggered in the ceiling cove. Rows are switched singly to provide flexibility in illumination level. The incandescent downlights use 150-watt reflector flood lamps. Wall cases are lighted with 72-inch vertical and 42-inch horizontal slimline lamps with 120 ma ballasts. Lighting data submitted by E. F. McDonnell, Jr., Commonwealth Edison Co.; Illuminating Engineer and Architects, Fred G. Dameier of Friedman, Alschuler & Sincere; Consulting Engineers, Robert E. Hattis; all of Chicago.



INSTALLATION AT UNITED LUTHERAN PUBLICATION HOUSE, 1228 SPRUCE STREET, PHILADELPHIA.

Lighting for Machine Sewing

LIGHTING OBJECTIVE: To provide suitable general illumination for sewing custom-made church vestments. Dark thread used on dark material presents a difficult seeing problem. While local lighting is furnished with the machines for the rapid perception of fine detail necessary at the needlepoint, the general lighting level needs to be sufficiently high to allow inspection of the finished product.

GENERAL INFORMATION: The area shown is 17 feet wide, 36½ feet long and 11 feet high. Colors, reflectances and brightnesses are as follows:

	Color	Reflectance	Brightness
Ceiling	white acoustical blocks	70%	14.2 ft-L
Walls	light green	60%	53 ft-L
Floor	light modeled grey	23%	22 ft-L
Dado	medium green	21%	17 ft-L
Machine Tops	light oak	25%	58 ft-L
Cutting Boards	light tan	14%	23 ft-L

Brightness of lighting unit
Longitudinal, 30-degree angle — 3000 ft-L
Crosswise, 30-degree angle — 1100 ft-L

(over)

A.I.A. File No. 31

Figure 2. Close-up showing general lighting on machine table and supplementary illumination around needle.

INSTALLATION: Thirty-two (32) Kliglite (316 Delancey Street, Philadelphia) No. 2401 industrial fluorescent luminaires are installed in four continuous rows mounted 5 feet apart and 7½ feet above the floor. Each unit contains two 40-watt T-12 standard cool white lamps.

The resultant illumination after four months' operation is 100 footcandles under the outside rows and 120 in the center of the room. This general lighting plus the auxiliary machine light (Tung-Sol S.M.6 21-cp 6-watt lamp with reflector and lens system — supplied by Singer Sewing Machine Company as integral part of this model of industrial sewing machine) provides a total of 500 footcandles at the needle point.

Brightnesses are indicated above under "General Information."

Lighting designed by George T. Anderson, Jr., Illuminating Engineer, Philadelphia Electric Company.

Lighting data submitted by George T. Anderson, Jr., Philadelphia Electric Company as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Reflectorized Mercury Lamps and their Industrial Applications

By E. B. NOEL
E. A. LINSDAY

Mechanically made pinch seals for quartz arc tubes have been developed which provide improved performance and reliability. Equipment has been developed to roll the required 0.0006" flat section in a continuous molybdenum lead. The new techniques have been applied to 100- and 400-watt reflector lamps. The 100-watt lamp is finding application in the expanding field of black light inspection. Two new 400-watt reflector mercury lamps have been developed in R-52 bulbs to meet the persistent demand for sources which will provide well maintained illumination with a minimum maintenance of equipment.

FILAMENT lamps with integral reflectors are well known. They are widely used in industry because of the advantages of small size, low system cost, high reflector utilization, and good maintenance even under dirty conditions. Less well known is the fact that there are now four mercury lamps with integral reflectors having these same advantages plus higher efficiency and output. They are the 100-watt flood H100-FL4, the 100-watt spot H100-SP4, the 400-watt H400-R1 and the 400-watt color improved H400-RC1.

Fig. 1 is a photograph with a portion of the bulbs broken away, showing the relative sizes and constructions. The 100-watt lamps are heavy pressed glass in the PAR-38 size. They are identical except for the lenses which produce either a flood or spot distribution, as required. The 400-watt lamps have blown bulbs 6½ inches in diameter (R-52) with an overall frost. The H400-R1 consists of the well known H400-E1 400-watt arc tube mounted in a silvered R-52 bulb. The H400-RC1 is a similar lamp in which the reflector has been coated with a red emitting phosphor. Pertinent data on these four lamps are given in Table I.

Mechanical Pinch Seal Construction

From the very beginning of their commercial introduction, Type H quartz mercury lamps have been made with the ends of the quartz arc tube capped with a dome of low-expansion glass through which the tungsten lead wires are sealed. Such arc tubes are shown in A and C of Fig. 2a. While in general this has been a satisfactory construction, the use of the two types of glass necessary for making the graded seal does impose limitations. Even though the glasses have extremely high softening points, they are much lower than that of quartz, and occasionally this has been a source of trouble, particularly where reflector lamps have been overloaded and unduly confined.

Older than the glass and tungsten wire seal for quartz lamps is an all-quartz construction in which an extremely thin molybdenum foil is sealed under a vacuum into a thick walled quartz tube.[1] No attempt is made to match the expansions. The bond between the molybdenum and quartz is strong and

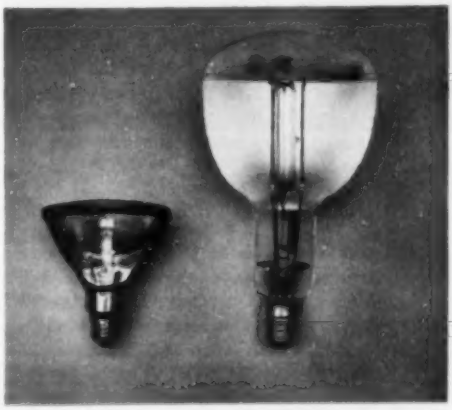


Figure 1. Sectional view of 100-watt and 400-watt reflectorized lamps. At the left is a PAR-38 100-watt pressed glass mercury lamp which is available with either spot or flood lens. At the right is a 400-watt lamp with blown R-52 bulb representative of either the H400-R1 or H400-RC1. Silver is used for the reflector of the H400-R1 mercury lamp, while the color improved H400-RC1 mercury lamp has an aluminum reflector covered with a phosphor. Both R-52 types have the neck clear (except for frost) to permit a small amount of upward light.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHORS: Lamp Development Laboratory and Application Engineering Dept., respectively, Lamp Division of General Electric Co., Cleveland, Ohio.

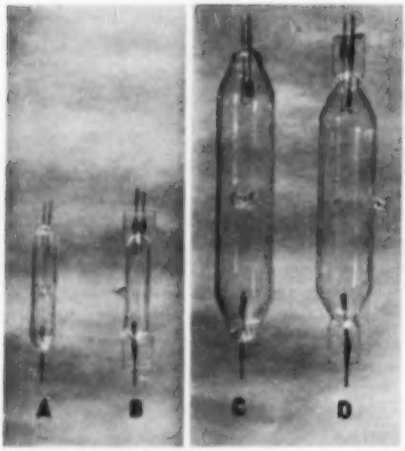


Figure 2a. (left) Glass-seal and pinch-seal arc tubes. A—100-watt quartz arc tube with glass seals. B—Improved 100-watt arc tube with rolled foil leads and mechanical quartz pinch seal. C—400-watt quartz arc tube with glass seals. D—Improved 400-watt arc tube with rolled foil leads and mechanical quartz pinch seal.

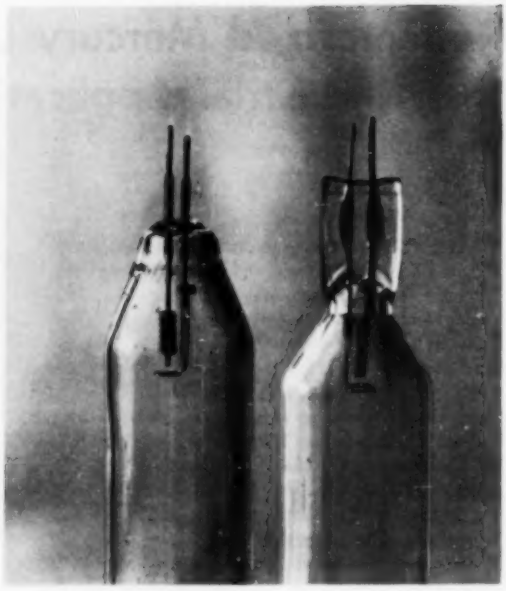


Fig. 2b. (Right) Enlarged views of 400-watt arc tubes. Left—Glass seal construction. Right—New rolled foil leads and mechanical quartz pinch seal.

the metal foil itself (0.0006-inch thick) so weak that the metal is deformed beyond the elastic limit during temperature changes. A number of industrial mercury and photochemical lamps are on the market today using this vacuum foil seal. Such arc tubes are more resistant to overload and to the harmful effects of radiation reflected back onto the arc tube than are arc tubes made with high temperature sealing glasses.

A new development is the rolled-foil mechanical pinch seal shown in B and D of Fig. 2a. Instead of welding a short strip of molybdenum ribbon between the inner and outer portion of the lead wires, a 0.0006-inch thick flat is rolled in a length of molybdenum wire. This avoids joints which are mechanically weak, and which may overheat and burn through because of lack of proper contact with the quartz. These rolled leads are placed in the open end of the quartz arc tube where they are protected by an inert gas while the quartz is heated and pinched around them. This operation, as well as that of rolling the thin section in the lead wire, is simple to describe, but actually very difficult and critical to perform. An enlarged view of the old

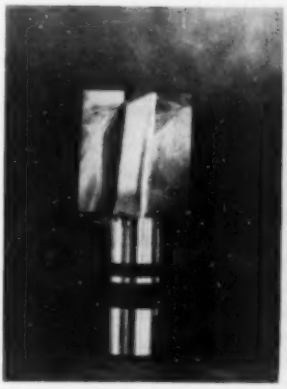
TABLE I.—Reflectorized Mercury Lamps.

Lamp	H100-FL4	H100-SP4	H400-R1	H400-RC1
Wattage	100	100	400	400
Initial Lumens	2300	2300	16,000*	12,300*
Approx. Mean Lumens for 3000 hrs. Life	—	—	14,000	10,700
Approx. Mean Lumens for 4000 hrs. Life	—	—	13,400	10,300
Rated Life at 5 hours per start	1000	1000	3000	3000
Rated Life at 10 hours per start	—	—	4000	4000
Bulb	PAR 38	PAR 38	R-52	R-52
Base	Admedium skirted	Admedium skirted	Mogul Mechanical	Mogul Mechanical
Burning Position	Any	Any	Any	Any
Max. O.A.L.	5 1/4"	5 1/4"	11 1/2"	11 1/2"
Lamp Operating Volts	130	130	135	135
Approx. Lamp Starting Current	1.3	1.3	5.0	5.0
Lamp Operating Current	.9	.9	3.2	3.2
Time to full output on lag circuits	3-8 min.	3-8 min.	5	5
Cooling time to restart on lag circuits	3-8 min.	3-8 min.	4	4

*Illumination calculations should be based on 20,000 lumens which are the generated lumens from an H400-E1 source.

Figure 3a. (top) Typical installation for "blacklight" inspection. Connecting rods, treated with penetrant and fluorescing powder are checked for flaws under a bank of H100-FL4 lamps.

Figure 3b. (bottom) Small part under visible and "blacklight." The left view taken with visible light shows no apparent flaw. In the right view taken under "blacklight" the flaw is easily seen by the bright fluorescence.



and new seals is shown in Fig. 2b. Machines have been built to do both the rolling of the foil and the pinch sealing on a production basis.

The General Electric H100-FL4 and H100-SP4 have been made entirely with a pinch construction for more than a year, while the H400-R1 and H400-RC1 at present are partly over to this construction. The pinch seals give improved performance where operating conditions are severe. In some extreme applications where conditions were such as to cause graded seal PAR-38 100-watt lamps to fail at around 350 hours, lamps with pinch seal arc tubes ran 2000 hours or more.

100-Watt Mercury Lamps H100-FL4 and H100-SP4

The 100-watt PAR-38 lamps are intended primarily for use as sources of "blacklight." Aluminum is used for the reflector surface because it is the best known reflector of ultraviolet and also because it lends itself to the pressed glass type of construction. Because of the blacklight service the outer surface of the reflector section is covered with an opaque black coating to prevent any leakage of visible radiation.

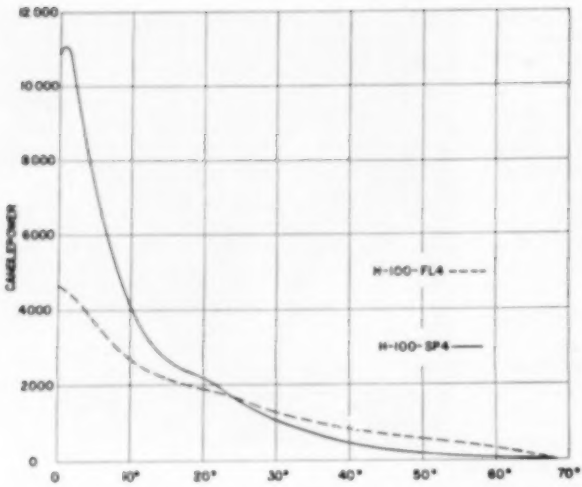
Since these lamps are similar in appearance to the incandescent PAR-38 lamps they are provided with admedium bases to prevent accidental insertion in unballasted standard sockets.

Blacklight service is often severe because of tight fitting housings and filter covers. In order to provide an added margin of safety for this type of application an improved arc tube having mechanical pinch seals was introduced in the H100-FL4 and H100-SP4 lamps about two years ago. Performance has been excellent, and this construction is now being extended to larger sizes of lamps.

Applications of the PAR-38 Mercury Lamps

Applications of these PAR-38 mercury lamps are expanding rapidly as additional uses for blacklight radiation are being found almost daily. They vary all the way from the spectacular theatrical uses to laboratory photo synthesis. Probably the most familiar application is the inspection of metal parts for cracks or similar defects. Fig. 3a shows a typical installation used for this purpose. There are several variations of this inspection technique. A common method consists of cleaning, dipping in a penetrant, wiping off the excess, and dusting with a fluorescing powder. Any defect retains some penetrant to which the powder adheres. The treated part is then inspected under "blacklight" with a minimum of visible light present. The defect is made strikingly apparent by means of the brightly fluorescing powder. Fig. 3b shows the appearance of the same part seen under visible and blacklight.

As in the above case where the material does not naturally fluoresce, many applications involve the addition of a fluorescing material. For example, sorting and identification of similar parts is greatly simplified by using different fluorescent colors. The dairy industry also uses a fluorescent additive in the cleaning operations to check for otherwise undetectable residue on their processing equipment.



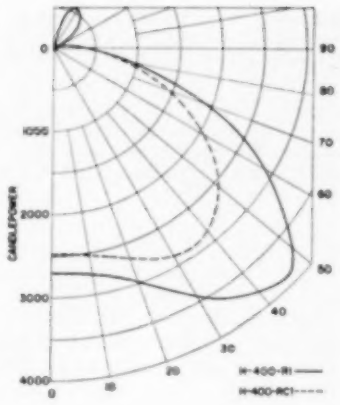


Figure 4a. (left) Distribution of 100-watt PAR-38 mercury lamps. The curves show the candlepower distribution of the spot and flood types. The distribution of near ultraviolet radiation follows the same pattern.

Figure 4b. (right) Distribution of the 400-watt R-52 mercury lamps. The curves show the candlepower distribution of the total visible radiation of the H400-R1 and H400-RC1 mercury lamps. The upward light is the same for both lamps.

Many materials fluoresce naturally. For example, in the refrigerator industry blacklight is widely used to check for oil leaks in the mechanism. In the oil industry it is used to inspect and identify oil, and to check for traces of oil in the oil well test cores. Perhaps the most unusual application of natural fluorescence is found in the inspection of eating establishments. The food inspectors use blacklight to check for rodent trails by the fluorescence of urine residue.

Many of these blacklight inspections involve small areas, or searching of larger areas with portable equipment. For these the H100-SP4 is ideally suited because of its concentrated spot and small physical size. Where more coverage is required the H100-FL4 is more suitable. This is the source used in Fig. 3a. The distribution of these two lamps is shown in Fig. 4a.

400-Watt Mercury Lamp H400-R1

The use of a 400-watt arc tube in a blown reflector bulb presented many design problems. In the first place, there was the matter of how to support the weight of the heavy arc tube. Support at each end (from the stem leads and from the center of the bulb face) was discarded in favor of a support from one end by means of a clamp around the stem tube. This type of design has proved quite satisfactory in large vacuum tube construction. See Fig. 1.

In the second place, the $2\frac{3}{4}$-inch linear light source of the 400-watt arc is not easy to handle in the R-52 reflector bulb. If a clear or lightly frosted bulb is used, some of the radiation is directed back on the arc tube because of the source length. This causes additional heating of the quartz, and reabsorption and loss of light. Also, for some positions of the arc tube within the bulb, radiation is concentrated on a small spot in the center of the R-52 bulb face. The use of a heavier bulb frost produces a more diffuse reflector surface and overcomes both of these difficulties. It also allows the arc tube to be mounted deep within the reflector. This produces a satisfactory light distribution and a reasonably good cut-off, as shown in Fig. 4b. Silver has the best visible reflectance of any known metal, and as used in the R-52 lamp produces a controlled beam having 80 per cent of the generated lumens of the arc. The sealed-in reflector makes possible excellent maintained lumens throughout life.

Color Improved Mercury Lamp H400-RC1

Improvement in the color of mercury light by means of phosphors on the lamp envelope was in commercial use in Europe before the last war, but neither the color nor the output was truly satisfactory. Two new phosphors sensitive to 3650 angstrom radiation and having low visible absorption with high red output at elevated temperature have

been developed for use in color improved mercury lamps.[2,3]

When a phosphor of this type is applied to the face of the H400-R1, satisfactory color modification is obtained, but the light output is greatly lowered by multiple reflection and absorption, and the good distribution is lost. The phosphor coated face acts like a secondary light source with a cosine distribution; consequently, the face is very bright and there is too much light near the horizontal. It has been found possible to greatly reduce these difficulties by leaving the face uncoated, and coating only the reflector. The light output then is 20 to 25 per cent higher, and the distribution much the same as for the H400-R1, as Fig. 4b shows. At first, attempts to coat the reflector were unsatisfactory as it was found that both the arsenate and germanate red phosphors attack the silver of the reflector. An aluminum reflector, however, was found to be satisfactory, and is used in the H400-RC1. The color rendition produced by the new H400-RC1 is equivalent to that of the more familiar H400-J1. (Approximately the same as combination mercury-incandescent system with equal wattage of each source.)

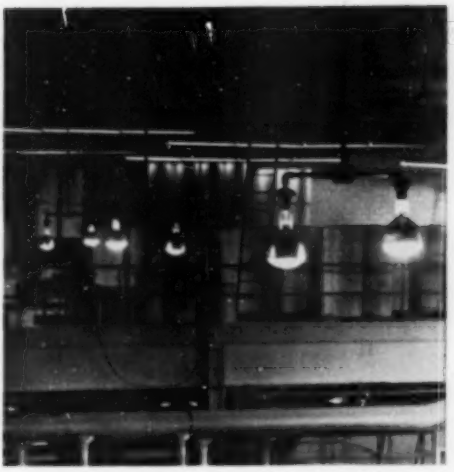


Figure 5. Color improved R-52 mercury installation. This test installation in a chemical plant has been in service for over two years and has given complete satisfaction. When first installed the lamps were used in existing fixtures. Later, as shown, the reflectors were removed in order to study bare lamp operation.

Applications of the R-52 Mercury Lamps

The basic advantage of reflector type lamps for general lighting service is their marked reduction in lumen depreciation because of the built-in reflector and the very limited amount of dirt which can collect on the bulb face when the lamp is mounted base up. The natural air currents around the lamp tend to prevent dirt accumulation on the bulb face. Recent tests indicate that even in the dirtiest environments for every 1000 hours of service less than 2 per cent reduction in output due to dirt is experienced.

These excellent maintenance characteristics undoubtedly explain the wide acceptance of the incandescent R-52 in the two years it has been available. These same features plus the added advantages of higher efficiency and output, make the R-52 mercury lamps particularly attractive for similar applications. Especially noteworthy is the fact that in many areas where higher wattage mercury lamps are unsuitable the H400-R1 provides light at the lowest overall cost. These reflector bulbs are designed for fairly wide candlepower distribution rather than the conventional concentrated reflector design. The wide distribution allows spacings of lamps to equal mounting height and still provide good uniformity of illumination. At the same time good vertical illumination is provided which is important in nearly all industrial areas. These lamps have been thoroughly tested under service conditions. Fig 5 shows a test installation which has been in service for a little over two years. The lamps in this installation are the H400-RC1 color improved type. This particular installation also uses incandescent lamps to provide immediate restoration of illumination in case of a power interruption. In this installation at first the reflector lamps were merely substituted for H400-A1 lamps in the existing reflectors. Later, as may be seen in Fig. 5, the reflectors were removed in order to study bare lamp operation. Operation in fixtures is the preferred method of utilization because of the relatively high brightness of the lamp in the zone between 60 and 90°. (This brightness is greater in mercury lamps than in the more familiar filament lamps because the mercury arc is a long light source. The small incandescent filament is quite well shielded in the R-52 bulb.) From a comparison of the candlepower distribution in Fig. 4b it will be noted that both the R-1 and RC-1 have essentially the same type distribution with considerable candlepower in the zone of 60° to 90°. It will be noted that there is some upward light which can be utilized to raise the brightness of the upper parts of the room. (See also Fig. 1.) When these lamps are used in reflectors, most of this light is intercepted by the reflector and a part of it redirected into the zone below 60°. Fig. 6 shows a sketch of a suggested ring louver for these lamps which when made of semi-specular aluminum gives

Figure 6. Drawing of proposed louver. The ring louver provides auxiliary shielding and also redirects some light from high angles into more useful zones.

35° shielding and redirects any intercepted light into the zones below 55°. This redirected light serves to raise the coefficient of utilization in narrow rooms, particularly when the side walls are dark. Fixture manufacturers are considering the relative merit of making equipment of this type available as compared to using standard deep bowl reflectors as shields. The reflector mercury lamps have been installed in several types of equipment designed for high mounting. This type installation has proved quite comfortable and has a maintenance factor of over .75. It is slightly lower than the figure of .80 which applies to the incandescent R-52 because of the much longer life of the mercury lamp.

Undoubtedly many of these lamps will be used without protective reflectors. It is well to caution that these lamps are not made of heat resistant glass, and so may break if water strikes them. Regardless of whether the R-52 lamps are used bare, in standard fixtures, or with a shield, they will give well maintained lighting levels with the minimum of servicing because of their long life and freedom from light depreciation due to dirt.

Acknowledgments

The authors wish to acknowledge the substantial and important contributions on pinch seal and reflectorized mercury lamps which were made by A. E. Binder, P. A. Dell, and E. C. Martt of Lamp Development Laboratory.

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Discussion of I.E.S. Conference Papers

Written discussion of any of the I.E.S. 1952 Conference papers for publication in ILLUMINATING ENGINEERING should be submitted immediately. Copies should be sent to:

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Author of the paper — for rebuttal.

Discussion organizer for the session (discussion organizers are listed on page 515, September issue, I. E.).

Structural Lighting in a Modern Home

By AILEEN M. PAGE

This paper discusses the designing of lighting for a modern house in which both general and local lighting are supplied from fixed or built-in luminaires. It appraises the lighting achieved and summarizes the pertinent design factors.

REQUESTS are increasing for lighting which is incorporated in the structure of the home. The techniques involved in such a lighting plan represent a pioneering coordination of living habits, architecture, materials, furnishings and lighting. The home illustrated here exemplifies the ahead-of-construction planning and the techniques employed when lighting is made a part of the house itself. It is hoped that this discussion of its lighting plan will benefit other designers.

The architectural design, furniture plan and interior design of this home were almost entirely developed by the owners to meet their specific living needs and to satisfy their own taste. Structural lighting was an important part of their planning.

The interior architectural design and some of the built-in features of this home are shown in Fig. 1. This is a picture of a ½-inch scale model built by the owner as one stage of its careful planning. A mechanical engineer by profession and a skilled cabinet worker by avocation, he built most of the custom-made lighting, as well as the cornices and coves. His wife is also practical-minded and equally skilled in her own hobby of sewing. Together they worked out details of unusually complete storage facilities and functional housekeeping aids which would delight any professional builder.

The careful planning for comfort, convenience and ease of housekeeping which went into this house is exemplified by the following list of its major electrical and mechanical features:

Complete winter and summer air conditioning
All-electric kitchen and laundry
(range, refrigerator, dishwasher, waste disposer, freezer, automatic washer, dryer, ironer)
Intercommunication system between kitchen, bedroom, front door
Telephone extensions in bedroom, living room and hobby room
Motor-operated draperies

In area, the house encompasses 1900 square feet, exclusive of the garage-workshop. There is almost head-high unfinished storage space above the living-dining-kitchen area. Ceilings are white and 8 feet in height. All walls, except in bathrooms, are paneled in wood — Philippine mahogany in the living room, white birch in the bedrooms, knotty pine in the hobby room and kitchen. Reflectance of living room walls is approximately 30 per cent; all other paneled walls run between 40 per cent and 45 per cent.

Most helpful in developing lighting for this home — and essential in any home using all-structural lighting — was the planned-on-blueprint layout of furniture, most of which was custom-built. The lighting plan started with provision for local lighting. Recessed downlights using projector or reflector lamps because of high output and controlled distribution were selected for many of these areas. For highlighting limited areas such as the cocktail and dining tables and plant bars sharpness and lack of diffusion gave glitter and sheen to polished surfaces and plants.

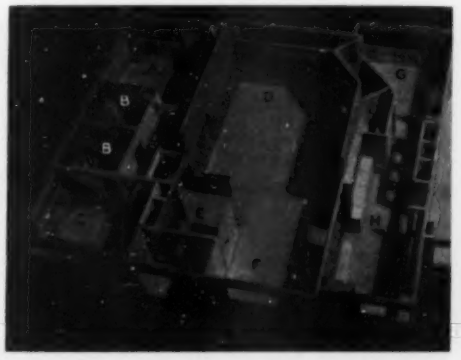


Figure 1. An accurately-scaled model of the home, built by the owner. Key: A—Master Bedroom. B—Bathrooms. C—Guest Room. D—Living Room. E—Reception Area. F—Dining Area. G—Hobby Room. H—Kitchen-Laundry.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHOR: Residential Lighting Specialist, Lamp Div., General Electric Co., Cleveland, Ohio.

Figure 2. View through window illustrates the dramatic effects attained by coordinating architecture, interior design and structural lighting in a modern house. It also emphasizes the need for skilled help and advance planning in achieving these effects.

Figure 3. (below) Whether to have draperies open or closed in the evening is a difficult choice. When open, the window becomes a mirror with exciting reflections of room and occupants. With downlights only, the rich French blue divan, the bluegray carpet, the lipstick red hassock and cushions, the brilliance of shiny leaves and blossoms look their most dramatic. This is first choice for entertaining.

For a more intimate atmosphere — and more comfortable casual reading — the gray faille draperies are closed. Since they are unusually billowy the cornice concealing 14 feet of T12 fluorescent lamps is built as far as practicable to obtain luminosity over the entire fabric (50 ft-L at top to 3 ft-L at floor). A shallow cove housing T6 operated at 120 ma is attached to lower edge of cornice for some helpful indirect lighting. Custom-built reflectors control brightness of cornice face to 25 ft-L and improve ceiling distribution — 48 ft-L above lamps to 5 ft-L four feet out. Photographic angle distorts actual positioning of downlights. Floodlamps are located above normal book position for three places on curved sofa, and spotlamp over glass coffee table.

Here, as in all other installations except coffer at entrance, de luxe cool fluorescent lamps were used.

These characteristics, so desirable for dramatic quality, are more difficult to work with where visual comfort is desired — and increasingly so as rooms become larger. Although quantities of light up to 350 ft-c can be developed with a PAR 150-w spot lamp on a visual plane 5 to 6 feet away, the problem of providing comfortable brightness ratios is greatly increased for values of this magnitude. At values of 20 to 50 ft-c, to be expected at similar distances from R-30 75-w and R-40 150-w flood lamps, acceptable brightness ratios are more easily provided, but must still be obtained by large-area light sources such as lighted walls and ceiling. Light floor coverings always improve visual field brightnesses and are essential where downlights are used extensively. Reflectances of 20 per cent to 30 per cent are recommended.

Another important consideration with these recessed luminaires is control of brightness of ceiling openings. It is always preferable to select those which are deep enough so that the bottom of the lamp is at least 3 inches above the ceiling opening. A recess of 5 inches keeps the bulb *entirely* shielded from normal viewing positions.

Figure 4. Effect of this 14-foot cornice and cove can be seen in Fig. 3. Inside of cove projection is painted white to minimize dark areas where sockets butt.

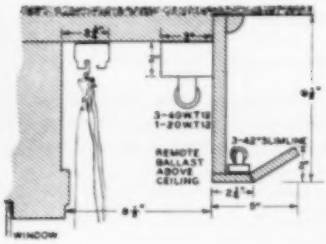


Figure 5. The need and contribution of the cornice-edge cove (unlighted) is emphasized here. The brightness ratio between cornice face and drapery — 150 to 1 — creates the basis of frequent objections to cornice lighting. Cove alone is also effective when draperies are open. The table top looks opaque, until interesting floor shadows reveal it to be glass. It is a perfect foil for the flood downlights which with their sharp, crisp light enhance the exotic and colorful centerpiece of Hawaiian-grown anthurium.

Figure 6. The bookshelves become an attractive part of the room's decoration when lighted. They also provide a needed bit of interest and of wall illumination along this side of the room. Concealed behind the side framing are 42-inch T6 lamps. The 120 ma ballast for these is located in storage space above living room.

Although their original purpose was purely decorative, the 75-w R-30 spotlamps above the plant box are turned on for at least 6 hours per day. The plants get no daylight but seem to thrive on this treatment.

Unfortunately luminaires such as those described above were not on the market when needed for the house herein described. Although there has been some improvement in the past year or two, there is still need for better design of downlights for projector and reflector lamps for residential use. Equipment is needed which provides 45-degree shielding and which in appearance is in better keeping with fine interiors. The type of luminaire selected was one which had a dark grey ½-inch deep louver immediately below the lamp. At a 45-degree viewing angle brightnesses ranged from 300 ft-L with a 75-w spot lamp to 2000 ft-L with a 150-w flood lamp. A 100 per cent reduction in brightness was effected by painting the louvers dull black.

Provision of large-area lighted backgrounds in the mahogany-paneled living room was the most difficult lighting-design problem in the house. Fortunately this room was used principally for entertaining rather than critical or prolonged eye tasks. With walls as low as 31 per cent in reflectance it was essential that ceiling and floor be reasonably light. They were 70 and 20 per cent respectively.

A total of 82 feet of in-built fluorescent lighting was used in this 20-ft x 33-ft room, in addition to the 13 downlights. With less than this footage — or with substantially darker finishes — the room

Figure 7. This record storage cabinet-plant bar has a recess 5¾-in. wide x 3¼-in. deep, next to wall, with louvered glass to shield 7 feet of T12 lamps. Three 75-w spot downlights 8 in. from wall create an interesting light pattern and, added to fluorescent light, raise wall brightness to 16 ft-L for improved ratios — important when viewing the television set at left of plants.

Figure 8. The reception area is set apart in a corner of the living-dining room by the fluted glass wall and by its individual lighting treatment. An oval coffer approximately 3-ft 5-ft is formed in a dropped ceiling 11½ inches below the actual ceiling. Located as shown in sketch (Fig. 9) four 40-w fluorescent lamps indirectly light the area to 5 ft-c. One blue and two pink lamps were chosen both for their relation to the basic color scheme and for their blend with the one white lamp to yield a subtle warm and hospitable atmosphere. Only paneled interior portion of coffer cavity is seen from normal viewing positions. Brightness is 35 ft-L.

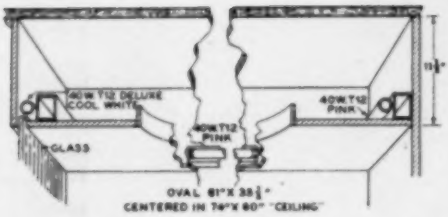


Figure 9. The color of the fourth 40-w lamp, not shown in sketch is blue. It lies perpendicular to fluted glass wall along side nearest dining area.

would lack the lighting comfort and flexibility it now has.

Windows covering the entire width of the two end walls and extending nearly to the ceiling were draped with 55 per cent reflectance grey faille. A special combination cornice and cove was designed for these window areas so that light could be reflected from the ceiling as well as the draperies. That this was considerably more effective and comfortable than a cornice with downlighting only, can be seen by comparing Fig. 2 with Fig. 3. It also added flexibility of lighting because each cornice and cove was controlled separately.

Cove lighting on side walls was also considered but had to be given up because it was not suitable architecturally and not feasible due to position of air conditioning vents and door openings. A 4-foot wide bookcase on one of these side walls and a plant bar on the other, offered opportunities for luminous areas. Although not extensive in area, these were nevertheless helpful decoratively as well as visually. The latter also served as an important aid to comfort in viewing the television screen immediately adjacent to it.

Lighting design for other areas was less complicated. Rooms were smaller and walls were lighter. It was possible to use large semi-indirect ceiling luminaires, in most cases in combination with built-in fluorescent local lighting. Bathroom lighting (not illustrated) consisted in one case of 15-w fluorescent mirror brackets plus a 32-w circline luminaire on the ceiling above bowl. In the other bathroom a 2-lamp 40-w fluorescent luminaire was mounted on the ceiling above the bowl. Each of these installations resulted in over 25 ft-c on sides of face.

In conclusion it should be pointed out that problems and considerations such as those outlined above will be present to a greater or lesser degree in *any* home where structural lighting is contemplated. Such a specialized lighting plan requires skilled lighting design consultation, first of all. In addition it is important that provision be made for:

(1) Advance planning — *before beginning of construction.* — Most of the general and some of the local lighting has to be specifically designed to fit the space and conform to the architecture of the house. Consultation between architect, contractor, owner and lighting designer will indicate minor — sometimes major — changes in architectural design and construction detail. The furniture plan, too, must be worked out at this stage, since lighting must be specifically planned and tailored to it. In

TABLE I.—Summary of Lighting Equipment.*

Recessed downlights — 17
5 R-30 75-w spot lamps
1 R-40 150-w spot lamp
10 R-40 150-w flood lamps
1 PAR-38 150-w spot lamp
Cornice lighting** — total of 52 feet
Cove lighting** — total of 26 feet
Fluorescent** — inbuilt in structural elements — total of 70 feet
Ceiling-attached fluorescent** and incandescent luminaires — 18 (bedrooms, kitchen, hobby room, passageways, closets, bathrooms)
Total wattage in house* — 5603
Total length in fluorescent lamps — 201 feet

*Exclusive of garage and exterior.
**De luxe cool lamps used throughout.

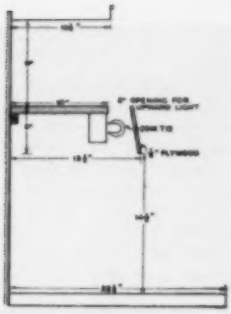


Figure 10. (above) This pine-paneled hobby room is the real "seeing" room of the house. Its clever built-ins, designed and made by the owner, make every square inch count. The dark green draperies shown here have been replaced by light green sheer ones of 55 per cent reflectance, shown in Fig. 12, a real improvement in visual comfort.

The 18-inch-square luminaire using five 60-w white lamps ranges in brightness from 300 to 1100 ft-L but is out of the visual field at all eye-use centers. General lighting averages 12 ft-c. On desk top, an average of 50-60 ft-c with little specular (none if work tilted to 30-degree angle) results from positioning of 25-w fluorescent lamp over work plane center (see Fig. 11). The 2-inch opening above lamp improves brightness ratios between visual task and field. Reflectance of desk top is 40 per cent, wall, 45 per cent.

Figure 11. (above left) Open-top shelf above desk in hobby room with 25-w fluorescent lamp positioned above work plane center.

Figure 12. (above) Another example of "a place for everything and everything in place" is this expertly-planned sewing center. A 4-foot circle of light from recessed adjustable 150-w PAR-38 flood lamp measures 40 ft-c at edges and 130 at needle. Slightly to left and behind operator, its 10-degree tilt toward wall, combined with light from ceiling luminaire, produces 35-50 ft-L on drapery in visual field. Overcast daylight averages 100 ft-c with draperies partially open. Tree leaves in summer and translucent draperies in winter control sky brightness.

Figure 13. (right) Only a few steps from the kitchen, the hobby room with its own fireplace is a very cozy place for a snack. The "table" folds back against the wall above the sofa, which then becomes a comfortable reading spot or an extra guest bed when needed.

A 40-w and a 20-w fluorescent lamp mounted on under side of cupboard are not visible from normal reading position with pillows to shorten seat depth. They provide 30 ft-c on a 45-degree angle, in comfortable ratio to wall and floor brightnesses — averaging between 2 and 5 ft-L from ceiling luminaire. It is not in visual field because the room is only 10 x 10 feet.

Figure 14. Lighting is one of many time- and energy-saving conveniences in this 10½-foot x 21-foot kitchen-laundry. General lighting averaging 20 ft-c is supplied from two rows of four 40-w lamps, mounted with channels semi-recessed in ceiling. One instant-start and three regular ballasts are used. Clip-on louvers reduce brightness, viewed lengthwise, to 250 ft-L. Local lighting of 40 ft-c is provided at work areas from two 40-w lamps behind cornice and undercabinet light. Undercabinet lighting is provided by a T6 72-inch lamp mounted on the back of the 1¼-inch deep cabinet framing.

Automatic washer, dryer and ironer are along wall at right (not shown in photo). When in use, ironer is moved under ceiling luminaire for 30 ft-c. Best daylight illumination here is only 5 ft-c because of 12-ft distance from window.

the absence of portable luminaires which can be moved about at will when furniture is rearranged, unusual thought has to go into this original furniture plan.

(2) Coordination of interior finishes with the lighting design. — Particularly in rooms where critical seeing is done, the lighting designer must be allowed a voice in the decision on wall, ceiling and floor finishes. Reflection of light from these surfaces is always of importance in the comfort and effectiveness of the lighting result, but it becomes *vital* in certain forms of built-in lighting.

(3) A flexible budget. — The specialized equipment, precision workmanship on custom-built luminaires and the careful supervision needed cannot be secured with a limited budget. It would be wiser not to attempt extensive structural lighting if these limitations are present.

New Industrial Lighting Standard Practice Available Soon

The new American Standard Practice for Industrial Lighting has received full approval by the American Standards Association and will soon be available in a 40-page booklet published by the Illuminating Engineering Society.

The new Industrial Lighting Standard incorporates all recent developments in the lighting of industrial areas, including specific developments resulting from I.E.S. technical committee investigations and reports on lighting in various specific industries. Of particular value are the extensive tables of tasks with many manufacturing categories from "Airplanes" through "Woodworking," showing footcandle levels for each. Recommendations for quality of light, distribution and diffusion, brightness ratios and reflectance values are given. The booklet is illustrated with photographs and charts containing useful information.

The new information contained in the American Standard Practice for Industrial Lighting soon to be published will be of inestimable help to architects, consulting engineers, construction engineers, lighting company personnel, industrialists — in short to anyone planning to gain maximum use of improved lighting for increased production in industry.

A.I.A. File No. 31

INSTALLATION AT CHICAGO, MILWAUKEE AND ST. PAUL DIESEL SHOP, MILWAUKEE, WISCONSIN.

Lighting a Locomotive Servicing Pit

LIGHTING OBJECTIVE: To illuminate the running gear of diesel locomotives to facilitate maintenance and repair.

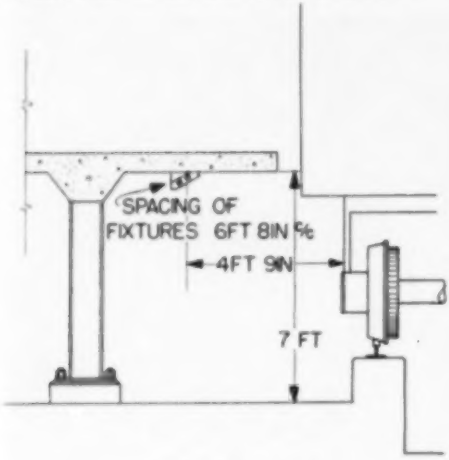
GENERAL INFORMATION: This shop does major overhauling, repair and maintenance work on diesel locomotives. The work is done beneath the between-track platforms. Floor and ceiling are concrete, dark gray (10% RF) from oil, grease and fumes; and the locomotive parts to be repaired are also dark gray (approx. 15% RF).

INSTALLATION: Two 40-watt T12 fluorescent lamps are installed in specially-designed Day-Brite dust-tight luminaires with shatter-proof glass covers at 6′ 8″ intervals as indicated in the drawing. Vertical illumination maintained in service on the upper portion of the running gear is 20 footcandles, with 15 footcandles on the lower portion. Brightnesses are as follows:

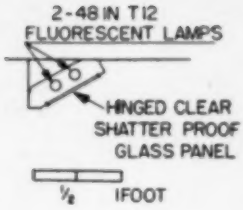
floor	0.7 ft-L
ceiling (between units)	0.5 ft-L
ceiling (in front of units)	1.2 ft-L
perpendicular to glass panel of lighting unit	1200 ft-L

(over)

A.I.A. File No. 31



Detail of luminaire.



Elevation.

Lighting designed by Earl Aik, Day-Brite Lighting, Inc., St. Louis, Missouri.

Lighting data submitted by W. C. Kuhnke, Wisconsin Electric Power Co., Milwaukee as an illustration of good lighting practice and to aid in the design of similar installations.

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The Kinorama as an Evaluator In Aviation Lighting

By F. C. BRECKENRIDGE

ILLUMINATING engineering is the child of two parents. Its descent from electrical engineering is generally recognized for in the early days the electrical engineer was also the only lighting engineer and the child is still dependent upon its parent for the power which makes its installations effective. The kinship of illuminating engineering to its other parent is not so generally recognized but is none the less real. I refer to psychology. No amount of radiation would serve any of the purposes ordinarily associated with lighting if there were no eyes to see it or no brain to interpret what the eyes see. Slowly, but inevitably, lighting research is becoming interrelated with experimental psychology. This dependency is even more important in signal lighting than in general illumination. It is the purpose of this report to describe a device which has been developed to test the psychological adequacy of approach- and runway-light systems.

In the ordinary applications of lighting, the illuminating engineer need consider only static relationships. Some study has been devoted, to be sure, to the movements of the eyes in scanning a line of print and some testing carried out to find the best means of illuminating a highway from a moving vehicle, but most engineers need introduce no velocity terms into their computations of the lumens and watts required for good lighting. In the approach-light problem, however, we are dealing with lights to be viewed by an observer who is generally traveling at a speed of 180 feet per second or faster, and the kinetic relationship is of the essence of the problem.

Following the second world war, there was an abundance of proposals for approach-light configurations, most of them advocated by their authors as the only safe form of guidance in fog. It became important to analyze these claims in an effort to determine which of the claims were well founded and which were wishful thinking. A drafting-board study taking account of the candlepower distribution of the lighting units, the transmissivity of the atmosphere, the altitude of the airplane, its cockpit cutoff, and the geometry of the configuration of lights did yield considerable information but attempts to interpret the results of this study led to a realization of the importance of the kinetic aspect of the problem and the need for a kinetic evaluator.

At the same time that the drafting-board studies were being carried out at the National Bureau of Standards, Mr. A. L. Lewis of the Bureau of Aeronautics was carrying out experiments with fluorescent models of airport lighting and conceived the idea of making such models more realistic by setting the fluorescent spots in motion. The kinorama resulted from a fusion of the two approaches.

The Laboratory Kinorama

The basic principle of the kinorama is to represent the lighting system to be studied by a model of such reduced size that it may be readily moved and to impart to this model the reciprocal motions of those which a pilot would have in landing over the system of lights to be evaluated. The test of the guidance afforded by a system is the reaction of the pilot and in order that this reaction may be significant the motions of the model must be those which would normally appear to follow the pilot's use of his controls.

In the kinorama the lighting units are represented by fluorescent miniatures. Since the most extensive motion of the pilot is forward, the fore-and-aft dimension of the model predominates and the forward motion can be simulated by mounting the miniatures on an endless tape of convenient dimensions and moving this tape continuously towards the observer. For lighting systems comprised of units that are all in one plane it is only necessary to represent the lights by small spots of fluorescent material on the surface of the tape, but for systems like the slope-line system in which the third dimension is significant the lighting units must be represented by miniatures which include the third dimension.

Fig. 1 shows the laboratory model of the kinorama which was completed in 1950. The cylinders for the forward motion may be seen in the figure mounted on a plywood platform. The transverse motion is simulated by moving this platform laterally on a wooden track. The yawing* is accom-

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHOR: National Bureau of Standards, Department of Commerce; Project sponsored by Bureau of Aeronautics, Department of Navy.

*The term "yaw" here refers to the horizontal angle between the center-line of the runway and the plane of symmetry of the airplane, following the dictionary usage rather than the technical aeronautical use which is related to the relative wind.

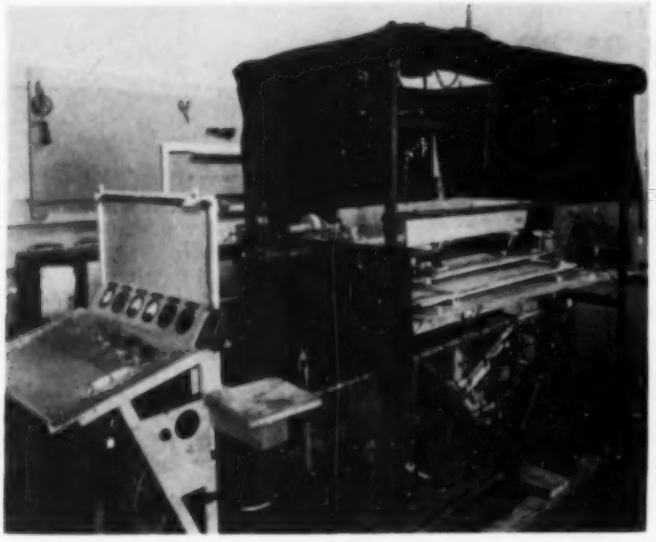

Figure 1. Laboratory model of kinorama showing controller's table in foreground.

plished by a corresponding rotation of the track platform about a vertical axis which is nearly under the point of observation. For the vertical motion, an approximate simulation was obtained by pivoting the bottom platform about a horizontal transverse axis located near the end farther from the observer. The motion of the near end is so much more conspicuous than that of the far end that the observer interprets this motion as a change of altitude, ignoring the incidental pitching of the scene below him. No provision has been made in this model for simulating the pitching of the airplane itself but banking is reproduced by an optical rotation to be described later.

One of the problems encountered in simulating a lighting system on the very small scale, 1 inch = 100 feet, which has been necessary to keep the overall dimensions within practicable limits, is to place the point of observation near enough to the tape to make the view correspond to that from points along the approachway and runway. This has been accomplished by the use of a telescope with negligible magnification and an objective approximately 0.5 inches in diameter. With a larger objective, it would not be feasible to bring the point of observation sufficiently near the lighting units and only the first stages of an approach could be simulated. With a telescope of sufficient length the pilot can sit in his seat normally and see the lights as if he were coming down among them. The telescope also simplified the problem of simulated banking. It was only necessary to install a dove prism at a suitable location in the telescope and rotate this prism to obtain a realistic simulation of a lighting system as seen from a banking plane.

The movements of the kinorama are controlled by motors. For the forward motion, which is kept at a constant speed for the duration of each test, a d-c motor with thyratron control proved satisfactory. A 24-volt d-c motor, with a variable shunt across the armature to control the speed and a dual field to determine the direction, has given usable results for the altitude and banking motions. For the transverse motion, which not only has to be reversible but closely proportional to the tangent of the angle of yaw, no adequate driving mechanism was found until a servo-motor was tried. This proved so satisfactory that a second servo-motor unit was built for the yaw motion.

The interrelationship between the yaw and the transverse motions has been mentioned. This is the most exacting one but several other interconnections between the several motions and controls had to be provided. The rate of yaw, for example, is partially controlled by the rudder pedals but it is also dependent upon the angle of bank. The transverse velocity has to be adjusted to the forward velocity but in the laboratory model this is accomplished by direct adjustment between tests. At first the vertical velocity was directly controlled by the stick. This seemed to be an oversimplification of the piloting problem, however, and the mechanism was redesigned to make the stick control a pitch motor the sole function of which was to control the ver-

tical velocity. This arrangement, however, turned out to be difficult to "fly" and a direct control was again installed but an inertia element has been inserted between the stick and the controlling potentiometer to retard the response somewhat.

Since the kinorama is intended to evaluate lighting systems that are designed especially for use in fog, it is important to limit the visible lights to those which would be visible in a fog of the assumed density. This means in effect that the ultraviolet flux used to irradiate the fluorescent spots or models must be controlled to give the limited visibility appropriate to the fog which is to be simulated. Three methods of doing this have been tried.

At the start, the irradiance was controlled by means of a template which was cut out to provide an opening of the correct shape and size to allow flux to reach the fluorescent spots only when they are within the visible region. In calculating this region allowance was made for the candlepower distribution of the lighting unit, the effect of the inverse square law, the transmittance of the fog, and the relative distances of the template and ultraviolet source. This method does not cause the spots to assume luminances in proportion to the brilliance of the lights in the positions represented by them. The luminance of the spots farthest from the pilot is somewhat less than that of the nearer spots because the more distant spots are also farther from the ultraviolet source but the ratio between the luminances of the near and distant lights is not nearly as large as it would be in fog.

To increase the ratio between the brilliance of the near and far units, a filter composed of layers of tracing paper was placed between the ultraviolet source and the tape. This device succeeded in making the brilliance of distant lights increase more slowly at first but the tracing paper scattered so much of the ultraviolet flux that the effect of the restricted beam width was largely lost so that it did not seem worthwhile to use the templates with the filter. It was also difficult to compute the reduction of irradiance and make the effect fit a desired pattern.

Experiments are now being made with a principle employed by E. S. Calvert[1] with visible light. The radiant flux passes through a rotating sector of such shape that the irradiance at any distance from the pilot is of the value required to produce the luminance appropriate to the distance, up to the maximum obtainable.

In all of these methods, the size of the available lamp has limited the precision attainable. So far only the CH4 100-watt, projector-flood, mercury lamps have been used, but a more concentrated source of ultraviolet radiation is desirable. Another limitation inherent in the use of fluorescent simulation is the limited luminance which can be obtained. The nearer lights in actual installations are generally glaring.

To carry out the evaluation program planned for the kinorama, it is necessary to prearrange what the pilot is to see and then record his reaction to the scene exposed. This required that the telescope be fitted with a shutter operated by the controller who presets the approaches from his station behind the pilot and also a pair of recorders which draw horizontal and vertical traces of the path followed by the pilot.

The Prototype Kinorama

The laboratory model of the kinorama was largely built by laboratory personnel. It was built on the fuselage frame of a wrecked airplane with plywood platforms moving relative to one another to provide the apparent motions. Ballbearings running on wooden tracks were used for guides and similar makeshifts were utilized throughout to expedite the construction and bring the cost within the small allotments available.

As soon as this device had demonstrated that it is possible to achieve the desired simulations, the Bureau of Aeronautics made funds available for building a better model which should require less maintenance and be more efficient in use. This model is called the prototype kinorama and is scheduled for completion in July 1952.

In the prototype kinorama, the cockpit, instruments, and controls of a Link trainer take the place of those of the airplane and the plywood platforms are replaced by rectangular frames of aluminum alloy, as may be seen in Fig. 2. A true vertical motion has been substituted for the hinged movement and all the angular motions are simulated optically which simplified the mechanical design and makes it possible to provide the desired yaw movements with less width. Screw drives have been used in place of cables for the transverse and vertical movements and servo-motors have been provided for all of the movements including the recorder. One of the greatest improvements has been the provision of equipment for automatically presetting any one of nine initial states for the pilot.

The presetting is based upon the selection of one of the nine combinations of three altitudes with three transverse positions. With each of these combinations any one of three degrees of yaw, seven degrees of bank, and three degrees of pitch may be associated. The yaw, bank and pitch connections are accomplished by means of plug cords in the control chassis and are not intended to be changed from approach to approach but they may be changed between runs. It is possible to alter the cam positions so that different values of the several

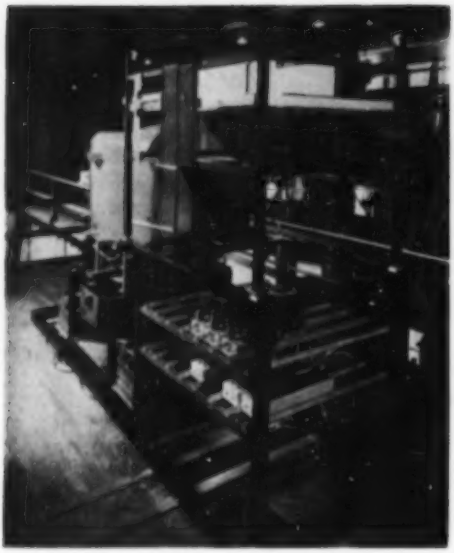

Figure 2. Prototype model of kinorama. Pilot's cockpit is at far end; controller's table will be at right of camera.

coordinates will be selected. The flexibility is sufficient to meet the needs of a wide variety of problems and baffle the subconscious memory that might try to guide a pilot through an association of the variables in fixed combinations and cyclic orders.

Procedure of Evaluation

The scientific evaluation of the guidance afforded by a system of approach or runway lights is a new field and as frequently happens in such cases there is as yet no scale for the measurement of such guidance. In the absence of some reproducible scale of measurement, we are limited to intercomparisons of definite configurations of lights. This limitation, however, does not relieve us from the obligation of organizing the work in accordance with the usual laws governing scientific research and if we wish to be able to combine the results of successive evaluations constructively, it is essential that the tests be planned in accordance with sound principles.

It is a maxim of research that the number of independent variables studied at one time should be kept to a minimum, the ideal case is one, and all other conditions should be kept constant if practicable, or if this is not practicable, such conditions must be made to vary in such a manner that their effect may be assumed to be null.

The first step in carrying out an evaluation is to determine what is to be evaluated. In view of the principles just stated, evaluations are preferably limited to the intercomparison of two, or at most, three configurations of lights and these should differ with respect to some single variable or principle, while in all other respects they should be as nearly alike as is practicable. If this condition is not met, it will be impossible to derive any generalizations and we can only conclude that one configuration is demonstrably better than the other or that neither configuration shows a definite superiority. Since we cannot say to which, or what combination, of the differences between them the superiority belongs, it is difficult to apply such conclusions to any other configuration of lights.

The second step in the evaluation is the selection of suitable criteria. It is necessary to have criteria which may be related on the one hand to the differences in the configurations to be evaluated and on the other hand to differences which may be anticipated in the recorded traces. To understand the limitations in available criteria it is necessary to consider the test procedure.

The basic procedure is to present a sequence of kinetic spatial arrays to an observer and determine from his reactions whether or not he has correctly interpreted what he saw. The sequence of arrays must be typical of what a pilot may be expected to have to interpret in using the proposed lights and, at the same time, it must be sufficiently comprehensive to include all the essentially different sequences that are important to flying safety.

For the studies made to date it has been assumed that the best reactions to use are the normal ones a pilot would make if he were in the situation represented by the spatial array he is seeing. These reactions lead to a new spatial array and hence the sequence of arrays is determined by the initial array and the pilot's reactions. This procedure has the disadvantage that the sequence is not the same for all systems, all pilots, or even for repetitions by the same pilot starting from the same initial situation. It has the great advantage, however, that a pilot's reactions, if correct, are rewarded by the change in the spatial array that he expected and avoids the very disconcerting effect of not having one's actions followed by the changes which one knows should follow them. The procedure also has the advantage that each step in the sequence is introduced naturally. Some arrays will no doubt occur more frequently than others but, on the average, the frequency of occurrence in the test should follow reasonably well the frequency with which those same arrays would appear in service.

The following criteria have been used for evaluations: the delay in the initial reaction, the final error in the approach, the integrated departure from a normal track and the percentage of unsat-

isfactory landings. The delay in the initial reaction was taken as the time which elapsed after the shutter was opened before the correction was apparent in the record. The final error of the approach was determined by plotting the point at which the path of approach intersected a vertical plane parallel to the threshold and 500 feet ahead of it. The integrated departure from a normal path was defined as the area included between the normal path and the trace of the approach path. This determination was made separately for the horizontal and vertical traces. A landing was considered unsatisfactory if the approach path was below "ground level" before it reached the threshold or if it was outside of the edges of the runway at the time when it first reached ground level.

Having defined the configurations to be evaluated and selected the criteria to be applied to the results, the next step is to select the observers. The first consideration is to limit the selection of observers to a class of pilots whose reactions may reasonably be assumed to be those of the pilots who would be using the lights if they were in service. Persons with little or no piloting experience may be useful on tests to determine the psychological characteristics of people in general or to check the performance of the kinorama, but they cannot be used for evaluating proposed configurations since it cannot be assumed that their reactions to an array are the same as those of an experienced pilot.

Another aspect of the program which must receive advanced consideration is the order of showing the systems to be compared. The order of testing may affect the results in one of two ways. If the pilot becomes fatigued, his results on the last approaches may be poorer on that account. On the other hand, the first approaches may be less satisfactory because the pilot learns to control the kinorama better as the test progresses. To put any of the systems at the first or the last of a series under test on all runs would leave open the possibility that the results were due to the order of testing rather than to the characteristics of the system. This cannot be avoided by intermingling approaches on different systems but the effects of the order of testing can be made to cancel out by a planned variation of the order of testing from pilot to pilot. If there are only two configurations in the test, it is only necessary to have an even number of observers, half of whom test one system first and the rest test the other system first. When there are three systems, the observers should be grouped in groups of six and the order of testing so arranged that each of the six pilots follows a different one of the six orders that are possible for three things taken three at a time.

If the results of a test are to be significant, the pilots must be sufficiently accustomed to the kinorama so that they can control it without difficulty as otherwise the results may be obscured by large accidental variations arising from the pilot's efforts to control the kinorama. To acquire the needed skill the pilot must make a number of practice landings. For the practice landings, an additional system which is not to be evaluated should be used in order not to bias the observers with the results of the practice runs. If the evaluation is to be based partially or wholly upon the degree to which the landings follow a normal pattern it is preferable to determine each observer's normal approach as his standard for the evaluation. The neutral system may be used to determine the normal landing path. The normal path should be determined with the ultraviolet controls set to simulate unlimited visibility.

Results of Evaluations

Three evaluations have been undertaken. The first of these was a comparison of three "over-run" lighting systems, the second a comparison of three approach-light systems and the third a study of runway markings.

The "over-run" is a stretch of pavement, at one end of a runway, which has not been built for regular use but must be kept free from obstructions for emergencies. This necessity precludes the installation of some types of approach-light systems on "over-runs" and has led to the development of special "over-run" lighting systems. The three systems compared were all designed at the Wright-Patterson Air Force Base and differ in the types of lighting units used. For one system the lights were effectively point sources, the two sides being distinguished by the use of pairs of white lights on the left side and single yellow lights on the right side. For the second system the single and paired units were replaced by groups of smaller units arranged to form "L"s with the long side of the "L" parallel to the approach. In the third system short vertical legs replaced the long legs of the second system. Perspective foreshortening, however, made the vertical and longitudinal legs appear about the same in length to the pilot. These systems were tested in conjunction with the outer 2000 feet of a slope-line system. No effort was made to obtain purely objective results for this test. Each pilot was questioned in regard to his views and these recorded. An analysis of the views expressed indicated that the "L"s were generally considered more satisfactory than the point-source lights but there seemed to be no consistent preference for either type of "L" over the other. This result is consistent with that reported by the Landing Aids Experiment Station at Arcata.

The approach-light tests were undertaken in the hope of determining which of the three approach-light systems outlined in the report of the Fourth Session of the Aerodrome, Air Routes, and Ground Aids Division of the International Civil Aviation Organization is based on the most valid principle. The three principles are the center-row, advocated for the simplicity and certainty of its guidance by Mr. Calvert of the British Royal Aircraft Establishment and by the spokesmen of the Air Line Pilots' Association in this country; the left-hand row, advocated by M. Baldino of the French Air Ministry for its better visibility; and the slope-line system advocated by Mr. H. J. C. Pearson of the Civil Aeronautics Administration's Development and Evaluation Center at Indianapolis because it furnishes precise vertical guidance and has distinctive units. Eighteen pilots from the U. S. Navy and Marine Corps participated in these tests.

A parallel-row system was used for practice runs and the results obtained with this system proved satisfactory for the establishment of normal approach paths for evaluating the test landings. All the methods of evaluation described in the previous section were tried but the results of the different evaluations did not show as high a correlation as seemed desirable considering the importance of the problem and the results are accordingly being withheld until they can be confirmed, revised, or disproved by additional tests, preferably with the prototype kinorama.

The test with the runway markings is in its initial phase at the time of this writing and no results will be available from them for some months. Thus far the program is elastic so that it is not even possible to describe the various elements to be tested.

While the subject of this paper is the kinorama as an evaluator, it would give a too limited view of the scope of the device if no mention is made of the practicability of using kinoramas to train pilots in the techniques of using approach and runway lighting and marking systems under conditions of low visibility. Under such conditions so little of the system may be visible as to bewilder a pilot who has only seen these aids under conditions of high visibility. If pilots are to land aircraft when visibility is less than a mile it is necessary that they become highly familiar with the appearance of the lighting system from all parts of the approachway under these conditions. It is hazardous to the pilots, the aircraft, and any people who are employed near the approachway even for pilots to undertake landings in fog unless they have already had a good preliminary training to familiarize them with what they may expect to see. The kinorama can readily prove a most valuable aid to safety by making it possible for pilots to obtain essential preliminary and refresher practice without risking either lives or aircraft.

Acknowledgments

The development of the kinorama has not been a one-man task. So many people have very kindly contributed towards the solution of its problems that adequate acknowledgments cannot be expressed to all. The contribution of A. L. Lewis in getting the work started has already been mentioned and the participation of A. B. Jordan, D. W. Mader, R. T. Vaughan, and M. E. Rose as colleagues has been invaluable. Mr. E. J. Uhlig of Forway Industries has also been very helpful with a number of suggestions regarding the actual construction of the prototype model.

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National and Local Officers

Photographs of members of Council and the Section and Chapter Chairmen will be found on pages 27A, 28A, and 29A. A list of Section and Chapter Chairmen and Secretaries begins on page 31A.

Silhouette Lighting of Small Diameter Wires

By WILLARD ALLPHIN

BECAUSE of the use of jigs and fixtures and of automatic machinery, difficult visual tasks in industry are not as common as might be supposed. An exception is the electronics industry, where tubes are becoming smaller and smaller and their components more and more difficult to see in assembly. An example is shown in Fig. 1, enlarged 3 diameters, and this by no means represents the smallest items, many of them being classified material.

The assemblies, or "mounts," are usually made by girls and women, requiring some of the skills of a watchmaker on the particular operation for which each is trained, but utilizing a much shorter training period and a narrower range of abilities.

The smallest parts of a mount are almost always wires, formed into filaments, grids, leads and the like, and these can usually be seen best in silhouette. There are welding and other assembly operations where silhouette lighting is not feasible, but there are usually stages in such an operation when the task is viewed against a light background for checking purposes. Surprisingly little appears in the lighting literature about this type of lighting, other than passing references to the fact that some tasks are best seen in silhouette.

What is the best background? What should its brightness be? Does light on the front of the task interfere with seeing it? This report deals with a laboratory investigation of the principle of seeing a fine wire in silhouette, and with a preliminary field application on the catwhiskers for silicon diode detectors.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHOR: Sylvania Electric Products, Inc., Salem, Mass.

The Experimental Visual Task

In order to standardize the task for laboratory purposes ,the wire frame shown in Fig. 2 had four filament wires welded across it, in diameters of 0.0077, 0.0033, 0.0014 and 0.0006 inch. From the various wire sizes available these were chosen because they diminish in size in approximately logarithmic steps.

Apparatus

The experimental task of Fig. 2 was supported in front of an easel or an incandescent lamp and reflector covered with flashed opal glass, depending upon whether front lighting or back lighting was being studied. The lamp was controlled with a Variac, as was the spotlight used for front lighting. The spotlight had a 125-watt projection lamp and a two-inch diameter lens, and was directed toward the task at an angle of 15° from a line of sight normal to the background. Brightness measurements were made with a Luckiesh-Taylor brightness meter.

"Contrast Sensitivity" was measured with a Cottrell meter. This might be considered to be related to "visibility," but Dr. Cottrell states in his paper[1] that he prefers the term "Contrast sensi-

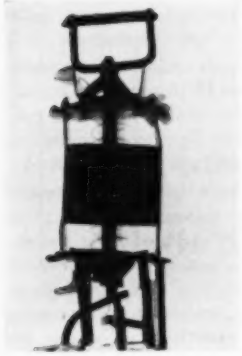

Figure 1. (left) Mount for a sub-miniature electronic tube. Enlarged 3 diameters.

Figure 2. (right) Experimental visual task. 4 wires in a frame ½ inch square. Wire diameters are 0.0077, 0.0033, 0.0014 and 0.0006 inch. Enlarged 3 diameters.

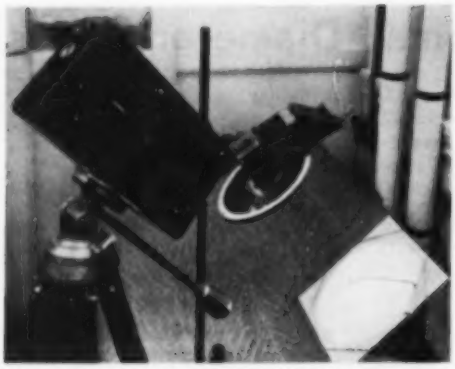

Figure 3. Apparatus arranged for measuring contrast sensitivities at different brightnesses of a self-luminous background. Brightness meter, contrast sensitvity meter, experimental task and opal glass background. (Camera pointed in predominantly downward direction).

tivity" rather than "visibility." The meter was a later type than the one described in his Pasadena paper. It requires no standard light source, but superimposes upon the task the brightness of the background as a "veiling" brightness.

In use, the variable density filter wheel is revolved until the critical detail just disappears, or just appears.

The contrast sensitivity,

$$CS = \frac{p + t}{t}$$

Where p is the transmission of the "periscope" or superimposed beam, t is the per cent transmission of the direct beam through the neutral-gradient filter.

In this case the meter was calibrated to read directly in contrast sensitivity.

Fig 3 shows the apparatus set up to measure contrast sensitivity with a self-luminous background.

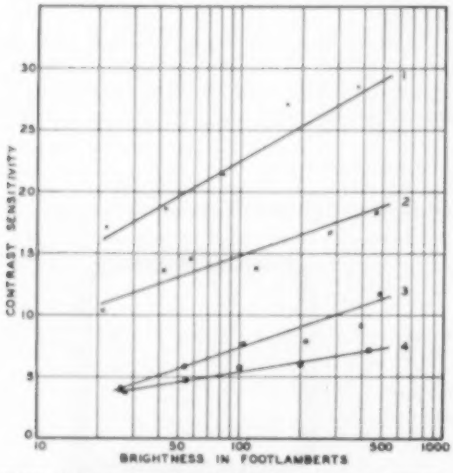

Figure 4. Four wires of experimental task viewed against self-luminous background.

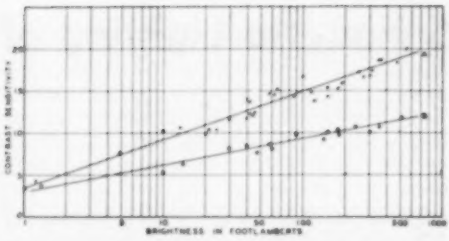

Figure 5. Wire No. 2 of experimental task. A—against self-luminous background. B—with front lighting and against white paper background.

Procedure and Results

Varying the self-luminous background from 20 to 500 footlamberts and using the four wire sizes, results were as in Fig. 4. Each point represents the average of ten observations at a particular brightness level. It is rather surprising that curves Nos. 3 and 4 should intersect, but further observations showed the same trend. Possibly wire No. 4 is so small as to introduce some effect other than what is being measured here.

Wire No. 2 was chosen for subsequent studies because its size is typical of those which are difficult to see, and because at a viewing distance of 14 inches its diameter subtends a visual angle of one minute. This is an angle which is frequently used in researches on vision.

Curve A in Fig. 5 covers considerably more data for the self-luminous background, each point again representing the average of ten observations.

Curve B is for the task seen against a white matte paper having a reflectance of 76 per cent. Illumination was from a spotlight illuminating both task and background. The front lighting of course reduced the contrast between task and background.

As might be expected, back-lighting is preferable to front-lighting, and maximum contrast is achieved when all light is excluded from the observer's side of the wire. However, such shielding would be difficult or impractical in some industrial situations, so it becomes important to determine how much the contrast sensitivity is reduced by

general diffused illumination falling on task and background.

Contrast sensitivities were obtained for wire No. 2, with and without 40 footcandles of general illumination measured in the plane of the background. This actually added another 20 footlamberts to the brightness of the background at all steps.

The results have been plotted in Fig. 6, C showing the contrast sensitivities without general illumination and D with it. For example, with backlighting alone the contrast sensitivity is 12.5 when the background brightness is 40 footlamberts. When the general illumination is added, the contrast sensitivity drops to 10, although the background is now brighter by the addition of 20 footlamberts. Note that D is with the addition of the general lighting but that the actual points represent only the self-luminous portion of the background brightness.

In another experiment using wire No. 2, a circular spot of 1.25 inches in diameter and having a reflectance of 76 per cent was mounted on a 9 x 12 inch background of 6 per cent reflectance, so that the spot served as the immediate surround to the task. Contrast sensitivities over a range of brightnesses were compared with those obtained when the entire surround was of 76 per cent reflectance. Although it could be argued that the white spot on the black background was less comfortable than the all white background, there was no difference in the contrast sensitivities.

Another possible source of annoyance in the use of a small bright spot for background is that the spot is seen as a double image when the eyes are focused on a task in front of it. Experiments indicated that a narrow strip running from side to side was preferable to the spot, but that when space permitted the use of a background 5 or 6 inches in diameter the double image effect was not pronounced.

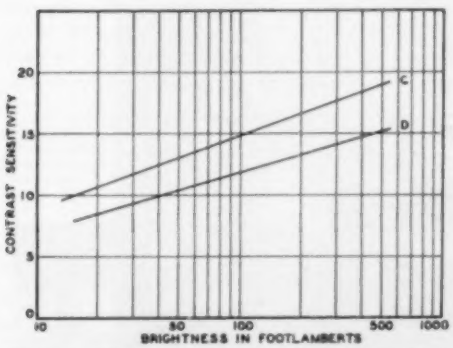

Figure 6. Wire No. 2 seen against self-luminous background. C—No front lighting. D—40 footcandles of front lighting.

Field Experiment

A self-luminous background was provided for experimental purposes in an electronics plant where operators were forming "catwhiskers" as described in a previous paper.[2] Opal glass was substituted for the filter in a darkroom lamp having an adjustable mounting. 15-, 25- and 40-watt incandescent lamps giving 210, 350, and 550 footlamberts of background brightness were tried in turn. The general illumination on the nearly vertical plane of the background was 20 footcandles.

Working on wire 0.002 inch in diameter the operators all chose the 210 footlambert brightness and much preferred it to the previous method of looking toward a piece of white paper having a brightness of 230 footlamberts under local lighting.

When welders, jigs, etc. are used, the work situations should be studied to see how the self-luminous backgrounds can be located near or even incorporated into the other apparatus, and how the task can be shielded from direct lighting when it is to be viewed in silhouette.

Discussion of Results

A study of Fig. 5 indicates that a self-luminous background is greatly superior to a front-lighted one. For example, it would take a front-lighted background of 500 footlambert brightness to give as much contrast sensitivity as a 21-footlambert brightness of the self-luminous background.

With any reasonable extrapolation of Curve B it can be seen that to equal the contrast sensitivity for a self-luminous background of 200 footlamberts, the front-lighted background would have to be impractically bright.

Brightnesses of 200 to 300 footlamberts are easily attained in small translighted panels and seldom contrast uncomfortably with their surroundings in a well-lighted factory. If there is any likelihood of discomfort, the illumination can be controlled with a foot switch or knee switch and lighted only when needed.

The importance of shielding the task as effectively as possible when viewing it against a self-luminous background is shown in Fig. 6. It requires 400 footlamberts of background brightness with 40 footcandles of general illumination on the task to equal the contrast sensitivity of a 100-footlambert background when general illumination is excluded.

Conclusions

The particular threshold measured by the Cottrell meter, and its relation to the bases of previous "visibility" meters, are points which are open to further discussion among vision researchers. However, considering the results obtained in the above experiments, neither a change in the name of the threshold nor a change in its numerical scale would alter the following conclusions:

Fine wires can best be seen in silhoutte against a self-luminous background.

The size of the background is not important from a standpoint of contrast sensitivity, but may become a source of some annoyance if it is very small.

Direct light should be excluded from the task insofar as possible.

In a small-scale field test with a vertical self-luminous background and most front lighting excluded, operators preferred a brightness of about 200 footlamberts.

The author gratefully acknowledges the loan of the ingenious contrast sensitivity meter from Dr. C. L. Cottrell, of Cornell University, and thanks him for advice and instruction in its operation.

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Three-Level Lighting in Low-Ceilinged Offices

In converting a former garage into an office for the Vice-President, the Philadelphia branch of the Howard P. Foley Co. installed a luminous ceiling offering three levels of illumination to the office occupant. A total of 18 72-inch T12 standard cool white lamps are mounted in single-lamp channels on the 8-ft 10-in. ceiling, 18 inches on centers above the acrylic plastic. Combinations of lamps on two circuits permit the selection of illumination level: 8 lamps give 50 ft-c; 10 lamps give 65 ft-c; all 18 together provide 115 ft-c. Walls are of striated plywood, painted light gray; furniture has a light green covering.

Edwin H. Henrie of Howard P. Foley Co., and G. William Wagner, Philadelphia Electric Co., collaborated in the lighting specifications.

Some Photographic Methods Applied to Photometry

By CHARLES MARSH

The collecting of photometric data by photographic means offers several advantages over other methods. Among these are speed, a large effectively infinite, number of points, and in some cases, automatic plotting of results. There are also disadvantages which have restricted its use. This paper describes some efforts to minimize the latter. Only those problems have been attempted in which the data required are in the form of variations of brightness. Of course, illumination may be determined from this brightness if the reflection or transmission factor is constant.

A SERIES of photographic negatives is made, with exposures increasing in a series, such as 1, 2, 4, —n. These are processed to produce images in black and white only, rather than in the usual scale of greys. The details of the photographic technique are given in an appendix at the end of the paper. A portion of such a sequence is shown in Fig. 1. These pictures were made in plotting the beam pattern of automobile headlamps. Determining the value at any point on the curve specifies it at every point, whether the curves are continuous or not. In this picture the units are in beam candlepower.

Should one wish to collect several curves into one picture, these negatives can be printed in register to produce a print such as that of Fig. 2. Greys are present in the picture, but their actual densities are unimportant, as it is their boundaries which are the contours of equal luminosity. It is necessary only that one can distinguish one shade from another. As many as twelve negatives can be printed on one paper. This method eliminates the problem of controlling all of the variables of photographic processing and the need to read densities to interpret results.

The information contained in Fig. 2 could of course be obtained by the usual method with more labor and no greater precision. However, there are some problems which would be much more time-consuming if done by the usual techniques. An example is the determination of illumination on a horizontal surface produced by the headlamp whose beam pattern has just been presented. Fig. 3 gives this information. The car equipped with these lamps was driven to a snow covered field and the distribution of illumination was photographed. Because small ripples in the snow made the edges of the grey areas indistinct when printed through a halftone screen, the boundaries were reinforced by an inked line. Only fifteen minutes were required to collect data from a lighted area about 200 x 500 feet.

An example at the other extreme of size is that of plotting the distribution of brightness of incandescent lamp filaments. The results of one series of negatives are shown in Fig. 4. Because of the low emissivity of tungsten, brightness is not necessarily directly related to temperature but may be augmented by reflections of hotter areas.

Some applications have been found in interior lighting surveys. Luminaires may be examined for brightness ratios, and areas having brightness between specified limits can be integrated. Examples are given in Figs. 5, 6, and 7. A complete installation is more easily specified by photographs of this type as one can be certain that there are no very bright or very dark spots which might have been overlooked in making a survey.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 9-13, 1952, Chicago, Ill.
AUTHOR: Electrical Engineering Department, The Pennsylvania State College, State College, Pa. Consultant to Westinghouse Electric Corporation.

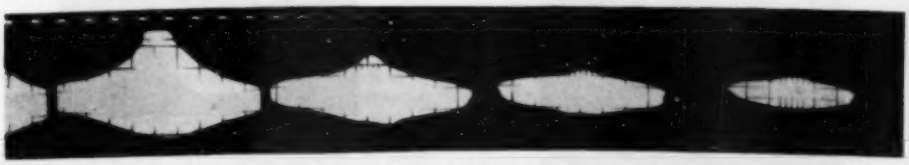


Figure 1. Headlight beam pattern. Contact print of a portion of the negatives used to make Figure 2. From left to right, each area's boundary represents roughly twice the beam candlepower of the preceding contour.

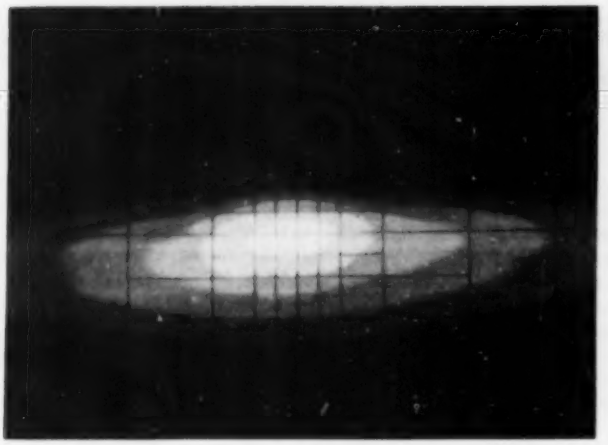


Figure 2. Beam power of an experimental headlamp. The coarse grid represents a four-degree angle. Calibration is from beam candlepower measurements made at selected coordinates at the time negatives were exposed.

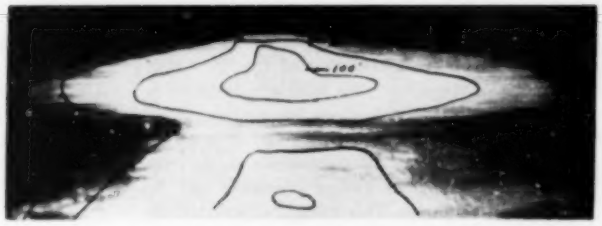


Figure 3. Actual performance of a pair of headlamps of the type photometered in Figure 2. The photograph was made with the car parked on a level field covered with fresh snow.

Figure 4. Flashlight filament. The photograph shows variations in the brightness of a 2.4-v., 0.8-amp. filament due to lead cooling. Temperatures may not safely be computed from these brightnesses because reflections by the ends of the filaments of hotter coils will increase luminosity.

Figure 5. Variations in brightness of a semi-indirect luminaire. From top to bottom, each boundary between the gray bands represents about twice the brightness of the preceding contour.

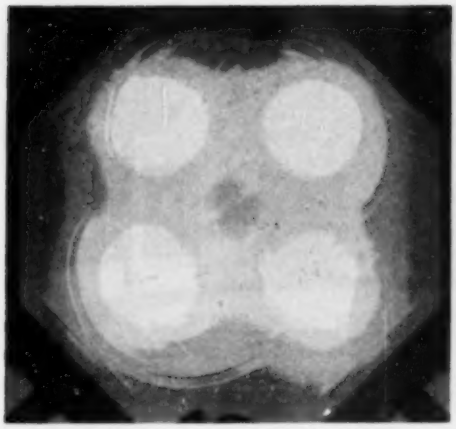


Figure 6. Brightness pattern of luminous architectural element. A ratio of 1:4 is evident. No spot within the four white areas has a brightness greater than twice that at the edges or it would have shown on the negative exposed for the next shorter time.

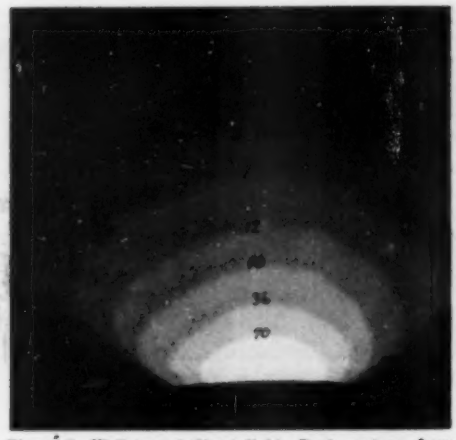


Figure 7. Wall type indirect light. Each contour, from bottom to top, represents twice the exposure of the preceding one. The numbers are brightness values corrected for Reciprocity Law Failure. (See paragraph on calibration.)

Calibration

Three methods of determining the values of the contours have been used. For small ratios of exposure using equal time but different lens aperture, the brightness may safely be assumed to be proportional to the squares of the *f:* numbers. From one measured point the others may be extrapolated. Where the range is too great for this, several direct measurements may be made and interpolation used to obtain the contour values. If the set-up is a permanent one, readings may be taken after the picture has been processed, at points directly on the lines desired. Where several points are not available and the range is large a correction factor may be applied to exposures whose relative lengths of exposure are known. Such a curve is given for one type of photographic film in Fig. 8. This deviation from a linear relationship is known among photographers as the Reciprocity Law failure.

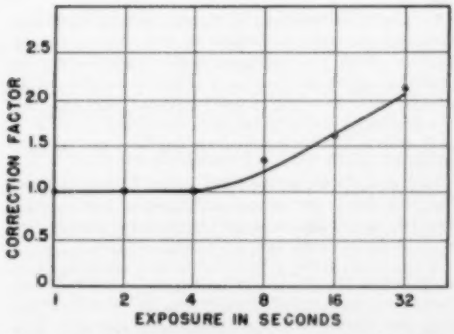


Figure 8. Reciprocity Law Failure. Correction factor for use with one type of film. If the lens aperture is held constant, one might expect the recorded brightness to be inversely proportional to length of exposure. However, very long and very short exposures produce less effect on films than the same number of lumen seconds delivered within an intermediate period. These factors are multiplied by reciprocals of the time to obtain the true brightness of the recorded scene.

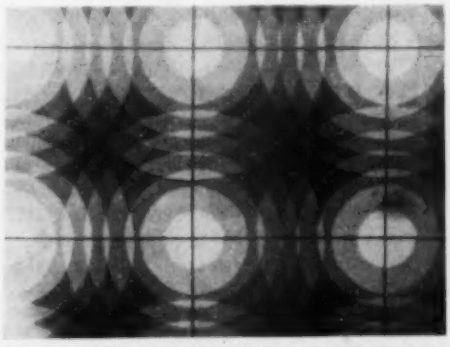


Figure 9. Solution by the point by point method of illumination distribution on the working plane. Lamps are spaced one and one-half times the mounting height. The circles represent illumination values through a maximum ratio of 6:1 from light to dark gray. The numerical values will depend upon lamp wattage and mounting height

Figure 10. An interior as photographed on Eastman Microfile and processed in D-11.

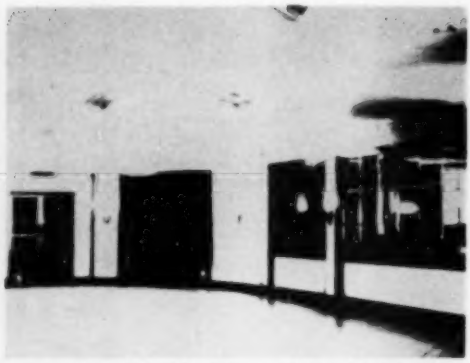


Figure 11. Print made from negatives made from that used for Figure 10 after gamma had been increased as described in appendix.

Point by Point Method

A variation of the methods described here can be applied to lessen the work involved in computing illumination by the point by point method. Fig. 9 gives the solution to one problem. It represents the illumination produced on the working plane by one type of direct luminaire when spaced one and one-half times mounting height. The boundaries between greys are isofootcandle lines and a given grey has the same significance wherever it occurs on the graph. The numerical values on the chart are influenced by the lamp size and the actual mounting height for a particular installation.

To make such a pattern, the distances are computed from a point on the work plane directly under one luminaire to other points receiving illumination in some proportion such as 1, 2, 3, —n. With these distances as radii, circular holes are cut in opaque paper, using a convenient scale. Photographic paper is exposed through each of these holes in turn, using a common center and equal exposures. This process is repeated at points corresponding to the locations of all the luminaires, using the same scale. The graph resulting from this is the negative of Fig. 9 and is quite usable as such. However, for some purposes reversal is probably desirable.

Only the basic process has been described. Several short cuts will be evident to anyone planning to apply this method.

Appendix

Photographic Techniques. — All exposures were made on fine grain, high contrast film and developed in D-11, a process developer.

If the convenience of a 35-mm camera is desired, the films available permit the negatives to be developed to a gamma of only about 4 or 5, not high enough to give sufficiently sharply defined images. Therefore contact prints can be made of the original negatives, on the same type film, and processed in the same manner. These positives can be printed on a third film to produce a second set of negatives of much higher contrast. The gain in gamma is shown in Figs. 10 and 11. This is not as tedious as it sounds. The first two films may be fixed and washed hurriedly and incompletely as they are not to be retained. Exposures for the positive and the second negative are not critical, but shorter times give less trouble from halation.

In projection printing, a hinged, opaque cardboard cover for the easel is helpful in obtaining acceptable register. With the enlarging paper placed under it, prominent markings from each negative may be traced onto the cover as an aid in positioning the following ones. Where unusual difficulty has been experienced, a print is made from one of the intermediate negatives and taped to the cover.

In plotting beam patterns the screen may be ruled or plain. If plain, two marks subtending a known angle from the light should be present to aid in the accurate use of a transparent scale over the enlarging paper.

A camera equipped with a fast lens is useful as exposures of four minutes at *f*:2 have been needed for headlights on distant screens. Ground glass focusing is helpful. Exposures are made in some progression, such as 1, 2, 4, — n seconds at a fixed *f*: number. There are advantages in keeping the time constant and varying the aperture if possible. For examining the brightness patterns of such subjects as diffusing globes, closer ratios are desirable: 1, 1.2, 1.44 have been used.

Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of E. H. Raddin, has prepared this listing of answers to frequently-asked questions. Readers are invited by the Committee to submit similar questions of general interest on light sources, to be considered for publication from time to time. Questions may be sent in care of Society Headquarters.

What are the distinguishing features of the carbon arc which determine its usefulness in particular services?

(1) High brightness (for projection), (2) spectrum control by means of composition of the carbon arc electrodes and (3) high power capacity.

See page 8-25, *IES Lighting Handbook*, Second Edition.

What is the function of the core of an arc carbon?

During consumption of the carbon electrode, materials from the core are introduced into the arc. These core materials are designed (1) to stabilize the arc or (2) to introduce flame materials into the arc to control the spectrum of the radiation emitted by the arc.

What percentage of the radiation from a carbon arc is within the visible wavelengths?

This percentage ranges from less than 10 per cent for some of the metal-cored electrodes designed for the production of ultraviolet to as much as 50 per cent for the rare earth cored carbons intended for the production of visible radiation.

What are the fundamental differences between a low intensity and a high intensity carbon arc?

There are basic differences in the electrodes, in the operating conditions, in the mechanism of light production and in the characteristics of the radiation produced. (1) Low intensity carbon electrodes consist essentially of carbon while high intensity carbons contain cores having a high percentage of flame materials, generally of salts of the cerium family of rare earths. (2) High intensity carbons are operated at several times higher current density than low intensity ones. (3) The source of light in the low intensity carbon arc is the incandescent surface of the electrode. In the high intensity arc, this is supplemented by the luminous vapors of cerium rare earths in the cup-shaped crater of the electrode. (4) The high intensity arc produces much higher crater brightness than the low intensity arc and the resulting high intensity arc light has a much higher color temperature than that from the low intensity arc. High intensity arc light has a color quality in the sunlight-daylight range.

See page 8-26, *IES Lighting Handbook*, Second Edition.

What is the crater brightness of the high intensity carbon arc?

The maximum crater brightness of commercially available high intensity carbon arcs ranges from 35,000 to more than 100,000 candles per sq. cm. Experimental arcs have been operated at more than 200,000 candles per sq. cm.

Is direct-current power necessary for carbon arcs?

No, both low intensity and high intensity carbon arcs can be operated with alternating or direct-current power. The electrodes for a-c do generally differ somewhat from those for d-c. The radiation from the a-c arc is modulated with a frequency equivalent to that of the power alterations. This modulation of the light is undesirable for some applications such as motion picture projection, and arcs for such usage are generally operated on d-c.

What is the effect of overload on a carbon arc?

An overload current may produce unsteady operation and may cause large increases in the rate of carbon consumption with only small increases in light output. In extreme cases, overload may produce electrode disintegration.

Are carbon arcs affected by magnetic fields?

Since the arc discharge consists of a current of electricity it can be influenced by the action of magnetic fields according to the usual electro-magnetic principles. Auxiliary magnets are employed in many carbon arc lamps to stabilize the arc burning and light output.

Lighting for Pin Drafting Machines and Three Blade Shear

Addenda to "Lighting of Woolen and Worsted Textile Mills"

The following deals with lighting for two textile mill areas not treated in detail in the 1949 "Lighting for Woolen and Worsted Textile Mills." At the time that report was prepared it was the intent of the Committee to continue its work by issuing addenda from time to time giving detailed illustrations of lighting practices for all important operations of the industry. These are the first of such additional data to be published.*

A-1. ***Lighting for Pin Drafting Machines.***—The pin drafting operation consists of feeding worsted slivers** grouped from a predetermined number of balls of top, located in a creel,** through a series of moving combs or gills which shake out, align, blend and draft the fibers to produce a well-blended and drafted heavy worsted roving. The stock usually passes through a series of two or three pin drafters before the roving is ready for spinning. The pin drafting operation replaces and reduces the number of operations of former heavy and medium drawing such as ball gilling, can gilling, intermediates, reducing, etc., and at the same time produces better blended and finer roving.

Localized general lighting is necessary over the entire area occupied by the pin drafting machines, the worsted stock ahead of the machines, and the stock of completed worsted heavy roving processed by the machines. Workers must have sufficient illumination to move about with safety, to see that the worsted stock is running properly through the machines, to see that different stocks do not become mixed in storage areas, and to read marking tags. Since there is a blending of several slivers into the final roving, the operator must check on the smooth flow of material and see that any one sliver does not run out without being replaced. Additional light is needed over the coiler heads where the flow of the material may be hindered by twisting and snarling.

For localized general illumination, industrial-type fluorescent luminaires in continuous rows running at 90 degrees to the direction of flow of the

*The reader is also referred to I.E.S. Lighting Data Sheets 6-16 and 6-17, respectively "Lighting of a Textile Finished Goods Perch" and "Lighting of Spinning Frames (Mules)."

**Sliver—Grouping of long wool fibers as received from the comb (after the card) into an untwisted rope-like form.

Creel—Any type of frame or container for holding any form of stock (balls of top, cans of roping, spools of thread, etc.).

For additional definitions see "Lighting for Woolen and Worsted Textile Mills," ILLUMINATING ENGINEERING, Vol. XLIV, No. 6 (June 1949).

Approved by the Council Executive Committee of the Illuminating Engineering Society, September 1952.

Figure 18. Feed end of pin drafters. In foreground balls of top (from combing machines) feed from creels into the first set of pin drafters, the output of which is deposited in cans at the coiler heads. In the background are located subsequent pin drafters feeding from cans.

Figure 19. (right) Coiler head section of pin drafters.

Figure 20. (below right) Close-up of coiler heads, location of the most critical seeing tasks in the pin drafting process.

stock are recommended. The space between rows may be varied as shown in Figure 21 to give more illumination for the more critical processes.

A-2. ***Lighting for a Three-Blade Shear.***—The purpose of the shear (see Fig. 22) is to cut the nap fibers of the cloth surface to obtain uniform length of the nap. This process is part of the dry finishing prior to pressing and final inspection, and after the cloth has been wet finished. The cloth feeds through the machine over a series of rollers and platforms and beneath three shears, each with an adjacent bearing surface.

The operator must check the material to see that the blades are not set too high, thus allowing

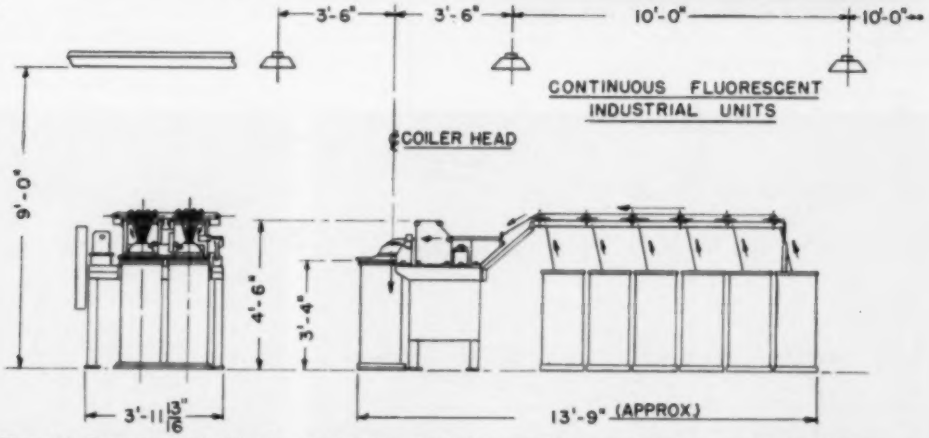


Figure 21. Recommended lighting for pin drafting. Luminaires providing approximately a minimum of 1000 lumens per lineal foot produce 75 to 80 footcandles over the coiler heads and 40 to 50 footcandles in the creel and storage area. In pin drafter rooms with wider creel and storage areas between rows of pin drafter heads, the 10-foot space can be widened to as much as 15 feet, giving satisfactory illumination of 30 to 35 footcandles in these areas.

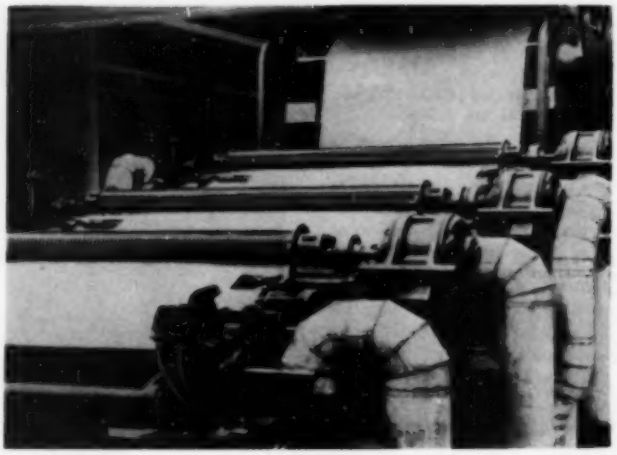


Figure 22. The final process on wool cloth is shearing, in which a fine, even finish is produced by shears which operate like hair clippers or a lawn-mower.

uneven nap of material to get through, nor set too low to cut off the nap. Also, he must watch for seams (where pieces are joined together) and raise the blades to avoid difficulty at those points. The operator must see the sides of the machine for checking operation and adjustment.

Figure 23 indicates the manner of illuminating the three-blade shear process. White or cool white type lamps are recommended.

I.E.S. Sub-Committee on Lighting in the Textile Industry

W. L. Kelley, Jr., *Chairman*

J. M. Shute	Walter P. Rayner
F. J. Vorlander, Jr.	Benjamin F. Roth
L. S. Cooke	Carl E. Rydman
John S. Dickson	F. E. Singleton
L. A. Kline	D. Mack Woodside

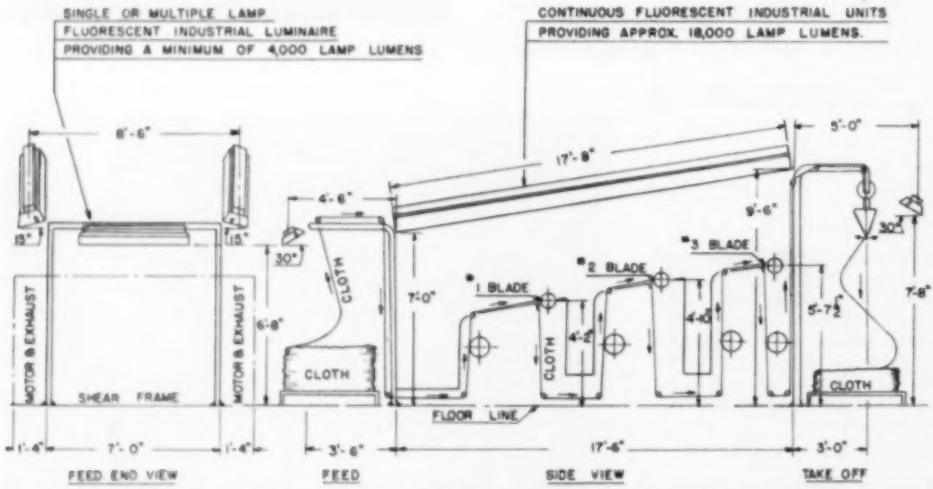


Figure 23. Lighting for a three-blade shear. A single or multiple lamp fluorescent industrial luminaire is mounted above the edge of the feed platform nearest the operator. A second unit is similarly installed over the take-off platform. The two rows of luminaires over the shear frame are tilted at an angle of 15 degrees from the horizontal toward the shear.

T E L E C A S T

LIGHTING NEWS OF CURRENT INTEREST

The 1952 National Technical Conference

A detailed report on the Society's most important annual meeting—the National Technical Conference—is intended to serve a three-fold purpose. To preserve for the record statistical details. To report to members not attending what went on. And, sometimes overlooked, to unscramble for those who did attend the impact of a thousand important impressions.

For the record—the Conference was held September 8 to 12 at the Edgewater Beach Hotel, Chicago, Illinois. Official registered attendance was 859 (Members 602, ladies 257). In the Society's history, this is second only to the Boston conference in 1948 which had a registered attendance of 906. In Chicago in 1952, however, the packed parallel sessions and attendance at all affairs leads one to suspect a large local attendance of non-registered members. A question frequently asked is "Where did we meet ten years ago, and how many were there?" For easy reference, site and attendance are shown in the boxed tabulation for the past ten years.

New developments in sources, auxiliary equipment and application techniques, dominated the technical sessions. A program of thirty papers, somewhat fewer then previous years, attracted extensive and especially valuable discussion. Pending publication of these papers in subsequent issues of ILLUMINATING ENGINEERING, complete sets of all 1952 Conference papers may be obtained from the Publications Office at I.E.S. Headquarters, 1860 Broadway, New York 23, N. Y. Again for the record, a list of the papers presented is given at the end of this report, this issue.

National Technical Conferences for Last Ten Years

1943	New York, N. Y. (1 day)	126
1944	Chicago, Illinois	721
1945	No Conference	—
1946	Quebec, Quebec	807
1947	New Orleans, Louisiana	605
1948	Boston, Massachusetts	906
1949	French Lick, Indiana	668
1950	Pasadena, California	556
1951	Washington, D. C.	765
1952	Chicago, Illinois	859

OPENING SESSION

The opening session of an I.E.S. National Technical Conference presents to the Society the sum total of the year's accomplishments as an organization. Technical progress is reported at the technical papers sessions; progress in industry and Society development is the function of the Progress Report. At the first session of the Conference, on the other hand, members receive a first-hand report from the out-going President on his Administration; from the in-coming

GOLD MEDAL, highest award of the Society, is presented to H. H. Magdsick by President Hibben.

NEW FELLOWS being presented with lapel pins by President S. G. Hibben are: R. M. Zabel, L. J. Schrenk, C. M. Cutler, L. J. Buttolph, E. W. Beggs, E. V. A. Rambusch, Wm. V. C. Fouiks, E. H. Raddin, E. M. Strong and G. P. Wakefield.

CO-CHAIRMEN, Papers Committee, meet with E. H. Raddin: R. M. Zabel, Roy Palmer, L. E. Barbrow and Mr. Raddin.

DISCUSSING the Conference are R. G. Slauer, Clarence Barry, J. F. Dickerson and T. C. Sargent.

Seen at the Conference

POSED before a display are Walter Sturrock, R. C. Close, and Carl Busch.

SUBJECT Streetlighting? In this photo are F. D. Wyatt, D. M. Finch and Charles Rex.

"INFORMAL discussion" is held by Edward Rambusch, Roy Palmer, C. M. Cutler and Hoyt P. Steele.

FIVE Wakefield Brothers meet: Ted D., Al F., George P., Fred W., and Ernest H. Wakefield at the Conference.

PAST PRESIDENTS' tables at the banquet — In the photo at left: (left to right around table): S. B. Williams, Mrs. Goddard, A. F. Wakefield, Mrs. Harrison, W. F. Little, Walter Sturrock, Charles Goddard, Mrs. Wakefield, Ward Harrison, G. H. Stickney; in photo at right: G. S. Crampton, Mrs. Stair, G. K. Hardacre, Mrs. Willard Brown, L. E. Tayler, R. B. Brown, Jr., Mrs. Hardacre, J. L. Stair, Mrs. Tayler, Willard Brown.

President on his plans for the next year; from the General Secretary on all details of the Society's operation. Not only as a call to order for a week of valuable meetings, but as the one meeting at which members may review their Society's affairs on a national scale, this session is one few delegates ever miss.

Hoyt P. Steele, Chairman of the National Technical Conference Committee, presided. A special feature of the meeting was an Address of Welcome by Major Lenox R. Lohr, President of the Museum of Science and Industry of Chicago, and currently President of the Centennial of Engineering being celebrated September 3 through 13 in Chicago. I.E.S. President S. G. Hibben responded for the Society.

Greetings from our sister society in London, the Illuminating Engineering Society (of Great Britain) were extended in a message from their President, J. G. Holmes, presented by a delegate from London, Dr. J. N. Aldington. Dr. Aldington, himself a Past-President of the British I.E.S., acknowledged the British Society's gratification in papers presented before their Society by American engineers, notably Dr. Ward Harrison, and this past year, by Mr. Henry L. Logan.

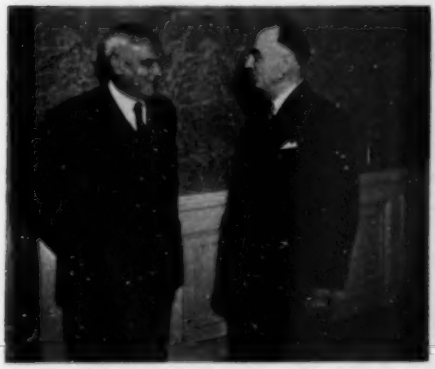
A similar message from Andre Claude, President of the French I.E.S. (l'Association Francaise des Eclairagistes) was read in French by Prof. G. Destriau, a delegate present for the Engineering Centennial from Sorbonne University, Paris. Prof. Destriau paid tribute to papers presented before their recent meeting in Toulouse by Messrs. Waterman, Manwaring and Commery (see I.E., July, p. 16A).

The Report of the General Secretary, Clarence C. Keller, will be published in full in the December 1952 issue of I.E.—must reading for all members. A full report on all committee work, publications, membership, finances, and all phases of I.E.S. operation was presented.

President Hibben's "Address of the President" was given at the opening session, and may be read in the September 1952 issue, page 473. In coming President, E. M. Strong, outlined the Society's course for 1952-1953; his address also may be seen in the September issue, page 475.

Gold Medal to H. H. Magdsick

The Society's highest honor — the I. E.S. Gold Medal — was presented during ceremonies at the opening session, to Herbert H. Magdsick, Executive Engineer with the General Electric Co., Nela Park. The Medal was established in 1944



DISTINGUISHED GUESTS present at the Conference. At left are: C. H. Howe, Minister of Defense Production of Canada, and Major Lennox R. Lohr, President of the Museum of Science and Industry; at right, President Hibben and Professor Strong chat with Professor Georges Destriau of France and Dr. J. N. Aldington of Great Britain.

for the purpose of giving recognition to especially meritorious achievement which has conspicuously furthered the profession, art or knowledge of illuminating engineering. Mr. Magdsick joins a distinguished list of eight I.E.S. Gold Medallists so honored by the Society. Other Medallists are: George H. Stickney, Preston S. Millar, E. C. Crittenden, Matthew Luckiesh, Sir Clifford Paterson, Ward Harrison, William F. Little.

The presentation to Mr. Magdsick was accompanied by the following citation:

"The I.E.S. Medal
Awarded to
H. Herbert Magdsick

Twenty-fifth President and Fellow of the Society . . . for more than two score years he has rendered Distinguished Service to the Society in many capacities . . . and to the Advancement of Illuminating Engineering along many avenues.

"Combining an analytical mind and a penetrating imagination, backed by extensive technical training and professional integrity, his pioneering works have added materially to the foundations for lighting practice and progress.

"Inevitably, his unselfish leadership and rare administrative ability were destined to leave indelible imprints upon Men, as his technical contributions have left upon Materials and Methods. His manifold contributions have permanently enriched the Society and the Professions it represents.

On the Occasion of the Annual
Conference of the
Illuminating Engineering Society
Chicago, September 8, 1952."

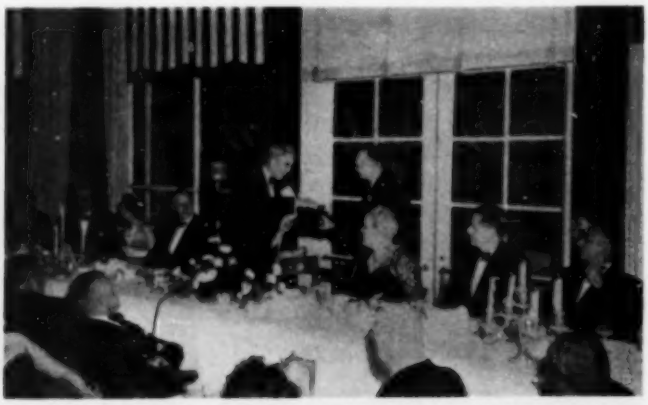
SCROLL and Past President's Pin is presented to outgoing President Hibben by President-Elect Strong.

It is typical of a man with such genuine accomplishments that he reply to the honor in words of modesty — in this case expressing a feeling of indebtedness to the Illuminating Engineering Society — after 42 years of service to that body! For the record, Mr. Magdsick's address of acceptance is given below:

"For many years I have felt myself deeply in debt to the Illuminating Engineering Society — to the men of vision and high ideals who founded this Society, and to those who have followed, for what they have given me of their aspirations, their knowledge and their experience — for what I have learned through participation in Committee assignments and other activities — for the honor of serving in official positions — and for the privilege of the congenial, stimulating association with people of many talents, all united in the up-building of a profession, in the rendering of a service that touches life constructively in so many and varied phases.

"And now you put me much more deeply in your debt by honoring me with this generous citation and the award of this medal. I accept it with humility, knowing that you are thus recognizing the contributions of groups of which I have been only one part. No one has been more fortunate in his associates

BAGPIPER Donald McKenzie of the Toronto Section, who piped in the V.I.P.'s to the head table shakes hands with E. E. Elliott, Chairman of the Entertainment Committee.



ATTENDANCE AWARD of gavel and anvil is presented to R. C. Pauley of New Orleans Section by President Hibben. The "travel gavel" goes yearly to the Section or Chapter who has the highest number of members present in percentage of total membership times distance traveled.

throughout the years than have I — nor in the conditions under which he has been permitted to carry on his activities.

"It has been my privilege to work with, to know well, all those who have heretofore been so honored by the Society. They have added the lustre of their character and accomplishments to the Medal. I shall prize it the more because of the respect and admiration in which I hold these men, keenly aware, as I am, of my own lesser stature.

"I recall, Mr. President, that you and I both entered the lighting field in the summer of 1910 and have since been continuously active in it. It is therefore a special privilege to receive the Award from your hand — and in this city, distinguished for its contributions to lighting progress and where just 41 years ago — at the Blackstone Hotel — I first appeared on the program of an I.E.S. Convention, and where we have from time to time returned for some of our most notable conventions — and in this State at whose University Professor Kraehenbuehl and his associates have in the past 15 years made such an important contribution to the training of illuminating engineers. It has been my good fortune to have a considerable number of their outstanding graduates as members of my staff.

"With the coming of Professor Strong to the presidency we are again reminded of the vital part educators have played and continue to occupy in the development of our Society and of the science and the art of lighting. A few of you older members are well aware that it was the lectures on light and illumination by the late Dr. Edward L. Nichols, Chairman of the Physics Department at Cornell University which aroused the interest that led Mr. L. B. Marks and others to undertake in 1906 the organization of the Illuminating Engineering Society, broadly conceived to bring together the contributions of the physical sciences, of engineering, of the psycho-physiological field, and the architect and creative designer.

"Like Mr. Marks, the founder, five of the first thirteen Presidents, as well as the twentieth President, had been students of Dr. Nichols — as were other leaders in the Society's technical activities such as A. J. Sweet and T. W. Rolph, to mention only two.

In its first 33 years the Society had five Presidents from the educational field, promoting its technical activities and advancing its professional prestige. And now after a lapse of fifteen years it is our good fortune to acclaim as our new leader Professor Strong, who rekindled lighting interest at Cornell University.

"Perhaps we ought to give further thought to the manner in which men come to the presidency. Is there not some danger that the pattern is becoming so fixed as to make the burden of leadership so onerous as to keep from the presidency other highly qualified educators? We need what they have to give in emphasis and leadership more than once in fifteen years.

"Like many of you, I should like to speak further in praise of professors, past and present. But at this time, I forego that temptation and say to you, Mr. President, and to the members of the Society, simply and sincerely: I am deeply grateful for the honor you have this day conferred upon me."

(Continued on page 11A)

RECEIVING LINE at the President's Reception includes Mrs. Hibben; President Hibben; Mrs. Strong; President-Elect E. M. Strong; Mrs. Manwaring; A. Homer Manwaring, V-P; Mrs. Keller; C. C. Keller, General Secretary; Mrs. Hartenstein; R. F. Hartenstein, Treasurer; Mrs. Steele; H. P. Steele, Chairman, National Technical Conference Committee; Mrs. Pederson, and Clarence Pederson, Vice-Chairman, Chicago Executive Committee for National Technical Conference.

PROGRESS was reported in skit showing the old and the new both in lighting, furnishings and women's fashions. Progress Committee Chairman Ted Sargent demonstrates that: A pretty girl remains a pretty girl — in any light.

RESIDENCE Lighting experts confer over program. Jan Reynolds, Chairman, Residence Lighting Forums Committee, shows program to Katherine Goodall, Edith Buchholtz, Myrtle Fahsbender, Mary Webber and Marianne Willisch.

THE GREEN LABEL DISTINGUISHES NEW G-E 40-WATT RAPID-START BALLAST FROM OTHER G-E BALLASTS—NOTE SIMPLIFIED CIRCUIT

New G-E Lighting Development

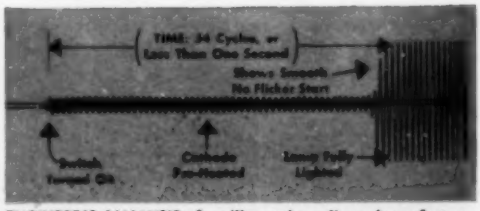
40-watt RAPID-START system eliminates starters

General Electric—first to introduce fluorescent lighting in 1938—now brings you a starterless system giving full, rated lamp life. New, electrically matched 40-watt **RAPID-START** lamps and ballasts do away with bothersome blinking at end of lamp life, give you eye-easy, no-flicker starts at a touch of the switch!

Present "instant-start" 40-watt fluorescent is costly, uses a heavier ballast—present "switch-start" is complicated by auxiliary starters and wiring—new **RAPID-START** system features smaller, lighter ballasts at a lighting cost comparable to 40-watt switch-start lighting.

General Electric lamp and ballast engineers have again combined their efforts to bring you a revolutionary development in 40-watt fluorescent lighting—the volume market. For new installations or to modernize old installations—a sales plus your customers will want! Act today. Contact your nearest G-E Apparatus Sales Office, or write Section 412-102, for complete information. General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC


TIME: 34 Cycles, or Less Than One Second
Shows Smooth No Flicker Start
Switch Turned On
Cathode Pre-Heated
Lamp Fully Lighted

ENGINEER'S ANALYSIS of oscillograph readings shows fast, no-flicker pre-heated cathode action of new G-E Rapid-Start.

Greatly magnified.

NEW G-E BIPIN LAMP, especially developed for fast, pre-heat starting, employs complex, triple-coiled cathode, right.

"My Most Interesting Lighting Job" Contest—Finale

Winners of the "My Most Interesting Lighting Job" Contest meet with Lee E. Tayler, Chairman of the Lighting Service Forum. Contestants are, left to right, seated: Hugh James, Lt.-Col. J. W. Howard, proxying for Roy E. Bevan, Earl Domoney; standing: Mr. Tayler, H. Neil McIntyre, C. H. Johnson, and Paul Hildebrand, Vice-Chairman of the Forum.

Earnestly studying the entries are judges Willard, Brown, A. H. Manwaring, S. G. Hibben, E. M. Strong, C. L. Crouch and J. S. Schuchert.

With ceremony (right) the prize is presented to Earl Domoney, Michigan Section, Great Lakes Region, by Chairman Lee Tayler. In the background are third and second place winners, H. Neil McIntyre and Hugh S. James.

(Continued from page 9A)

New Fellows Receive Pins

An interesting ceremony during the opening session was the presentation, made by President Hibben, of white Fellow lapel pins to 15 newly-elected Fellows of I.E.S. Certificates will be presented to each Fellow at an early Section meeting in the Fall. New Fellows receiving pins before the assembly were:

E. W. Beggs	New York
John E. Bock	New England
L. J. Buttolph	Cleveland
C. M. Cutler	Cleveland
Gertrude R. Ferree	New York
W. E. Folsom	Southwestern
William V. C. Foulke	Chicago
L. A. Jones	Rochester
E. H. Raddin	New England
E. V. A. Rambusch	New York
L. J. Schrenk	Michigan
E. M. Strong	Central New York
G. P. Wakefield	Cleveland
J. M. Waldram	Foreign-Non Section
R. M. Zabel	New York

Lighting Service Forum Inter-Region Contest

The Lighting Service Forum has over the past few years, developed into an eagerly-awaited feature of the Conference program. Regular delegates will remember with pleasure the performances in Boston, French Lick, Pasadena and Washington, in which lighting education was smoothly coated with most amusing entertainment.

This year's program, under Lee E. Tayler, Chairman of the Lighting Service Committee, took a completely different turn. One so successful nationally, that it will undoubtedly be established as a regular I.E.S. conference tradition.

The contest for "My Most Interesting Lighting Job," previously held by a few Sections as a local project, grew up to a national lighting application contest of considerable stature at the Lighting Service Forum program. Contestants were all winners of this all-I.E.S. contest at Regional Conferences. Contestants at the Regional level were first-place winners of local contests sponsored by 17 I.E.S. Sections and Chapters. So worthwhile did the program prove to be that all 57 of the Society's Sections and Chapters, and all 10 Regions, may well participate in this contest next year.

Grand Finalist Winners of the Lighting Service Forum's contest for "My Most Interesting Lighting Job" were:

First prize, $100.00: Early R. Domoney, winner for Michigan Section and Great Lakes Region. The Relighting of a Church.

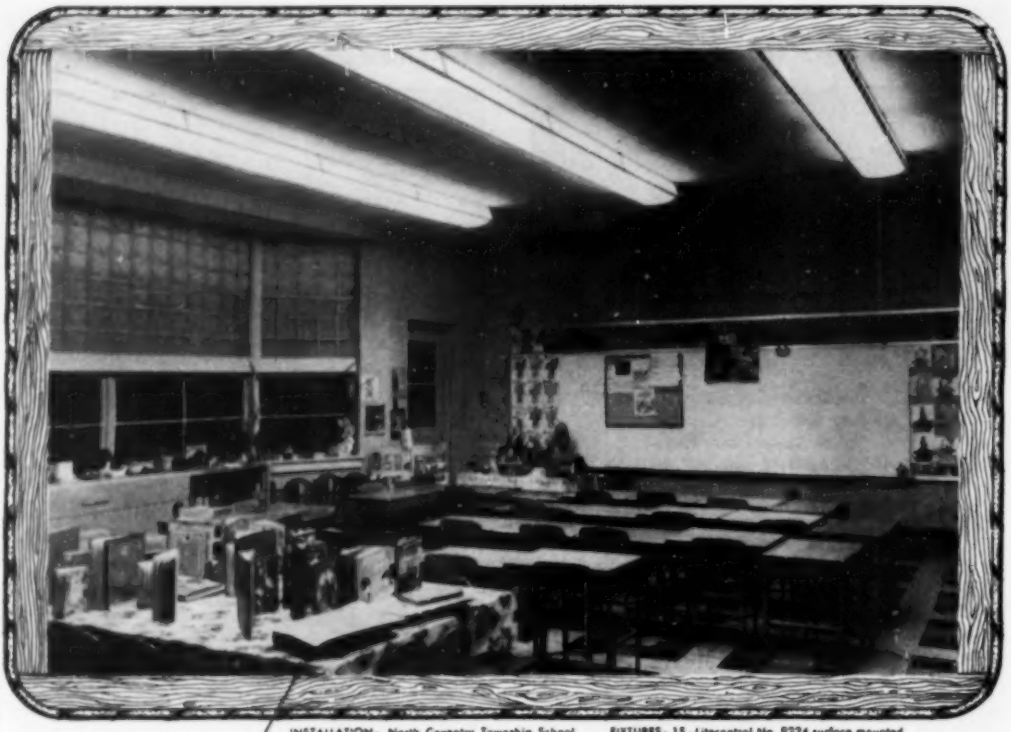
Second prize, $50.00: Hugh S. James, winner for Pittsburgh Section and East Central Region. Lighting the Syria Mosque.

Third prize, $25.00: H. R. McIntyre, winner for New England Section and Northeastern Region. Fluorescent Floodlighting an Airport Landing Apron.

Checks were presented to these winners before the entire assemblage at the Banquet, September 11, presentation being made by Lee E. Tayler.

Runners-up were also excellent examples of applied engineering. Carl H. Johnson, Midwestern Region winner, showed the remodelling of the Bell Savings and Loan Co., Chicago. Roy E. Bevan's winning entry (Pacific Coast Region) was presented in his absence by Lt. Col. J. W. Howard, U.S.A.F. This was the solution to a problem of lighting a church window. Judges for the contest

(Continued on page 13A)



INSTALLATION: North Coventry Township School, Pottstown, Pennsylvania.
DESIGNED BY: Eastern Engineering Co., Reading, Pennsylvania.
AREA: Lower Grade Elementary Classroom 24' x 30'.
CEILING HEIGHT: Approximately 9'-6".
FIXTURES: 15 - Litecontrol No. 9224 surface mounted, using Holophane No. 9100 CONTROLENS*
SPACING: 8'-0" on centers.
INTENSITY: On desk top beneath fixtures, 70 footcandles initially. Average over room, 47 footcandles initially.

Bright Solution

to an old classroom problem

...furnished by LITECONTROL

EYES have it easy in this light, attractive classroom. Note the even illumination... the absence of glare... the ease of seeing... all carefully calculated to protect young eyes... keep them alert and learning all day long.

Add to this the smart appearance of LITECONTROL's standard lighting fixtures No. 9224... plus their unusually low cost of upkeep... and there you have the three big advantages offered by LITECONTROL's *complete line* of standard lighting fixtures: Good light for good sight, with good looks, and easy maintenance.

When you want the same — a lighting installation that's custom in appearance... at standard fixture costs — consult your local LITECONTROL Representative. *Reg. Trademark

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

The Roaring Twenties Party

These "flappers" (above left), with Ed Riego, are Mrs. Lydia Pederson, Mrs. June Allen, Mrs. Ruby Neuhauser and Mrs. Gertrude Riego; while the Mack Sennett bathing beauties (above right) are none other than members of the New Orleans Section in the skit that won them the first place at the Roaring 20's Party.

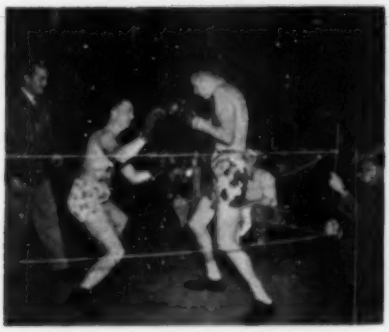
Striped blazers looked real sharp on E. E. Elliott, R. R. Hill and Jack Neuhauser.

Mr. and Mrs. William Kaiser shake a foot below while beside them the classic fight of "Gene Tunney" and "Jack Dempsey" is reenacted by members of the Twin City Section.

(Continued from page 11A)

were: Samuel G. Hibben, retiring I.E.S. President, Everett M. Strong, President-Elect, C. L. Crouch, Technical Director, Carl Zerseu, Manager, Chicago Lighting Institute and Joseph S. Schuchert, Manager, Commercial Sales, Duquesne Light Company.

Pictures and details of all five finalists, winners and runners up, will be featured in the November issue of ILLUMINATING ENGINEERING.



PROGRESS REPORT

As usual, the Progress Report played to a capacity audience, Wednesday evening, September 10. Here again progressive education is so entertainingly presented that visiting ladies and delegates alike enjoy it. T. C. (Ted) Sargent of Sylvania, Salem, Mass., presided as Chairman of the Progress Committee.

To quote the Conference bulletin:

"Other things that are progressive beside Henry Wallace and the income tax are:

(1) Lamps and circuits—rapid starts, lead-lag, constant voltage, mercury.

(2) In the industrial field — a mass display of many makes of 20 to 35 per cent upward and longitudinal shielded fixtures. And our silent service, the never-sleeping Navy, shows the result of six years of developing compact shipboard fluorescents; some so shielded that they emit no electronic nonsense.

(3) Novel residential fixtures for those with modern tastes. Just the things to look at through the neighbors' picture windows."

PRESIDENT'S BANQUET

Highlight of the well-planned entertainment program was, of course, the President's Reception and Banquet Thursday evening, September 11. The Marine Dining Room of the Edgewater Beach Hotel is an especially beautiful setting for such an affair, and the diners, 850 strong, were accommodated with ease.

The assembly was treated to a bit of formality rather rare in the United States when the head table personages were piped to their places by Bagpiper Jim MacKenzie, of the Toronto Section. Mr. MacKenzie was in full Highland dress (MacKenzie dress tartan, of course). The Chicago Committee, and all present, are greatly indebted to Mr. MacKenzie and to the Toronto Section for this thrilling touch. It was an impressive moment no one present will ever forget.

Other formalities, before the evening was turned over to the floor show and dancing, were presentations by President Hibben of several awards and the traditional presentation of the Official Gavel to the incoming President, Professor Everett M. Strong.

A standing ovation was given to Past-Presidents and their wives, who were at

(Continued on page 14A)

(Continued from page 13A)

a special table directly in front of the speakers table. Past Presidents attending the banquet included:

Mr. Walter Sturrock
Mr. Charles H. Goddard and Mrs. Goddard
Mr. Lee E. Taylor and Mrs. Taylor
Mr. G. K. Hardacre and Mrs. Hardacre
Mr. A. F. Wakefield and Mrs. Wakefield
Mr. S. H. Williams
Mr. R. B. Brown, Jr.
Mr. Willard C. Brown and Mrs. Brown
Mr. J. L. Stair and Mrs. Stair
Mr. W. F. Little
Mr. H. H. Magdsick
Mr. Ward Harrison and Mrs. Harrison
Mr. George S. Crampton
Mr. G. H. Stickney

Members Emeritus present were also asked to stand for the assembly's applause. Present were: Robert B. Burton, Sr., Oliver L. Hogue, Leonard V. James, W. T. Reace, Edwin D. Tillson, and C. A. B. Halvorson, as well as J. L. Stair and George H. Stickney, Past Presidents.

The banquet ceremonies concluded with the traditional presentation of the Past President's Pin, to Dr. S. G. Hibben —placed on his lapel by incoming President Strong.

Travel Gavel

Among other Society awards, two are eagerly sought at each Conference. One is the Gavel Award, which goes each year to the Section or Chapter having the largest attendance present in percentage of total Section membership, times miles travelled. The gavel and accompanying anvil was won again (as in 1951 and in 1940) by the New Orleans Section. The Award was received for the Section by Cecil Paslay, Southern Regional Vice-President. Second in the gavel contest was the New York Section with 53 present; third was the Toronto Section with 29 members present.

The Attendance Gavel was established in 1914 to be awarded annually to the winning Section or Chapter on the basis of miles traveled to the Conference and percentage of membership in attendance. The winning Section or Chapter name is engraved on the silver handle. In 1948, the British Columbia Section currently possessors of the by now completely engraved gavel, presented to the Society a silver-mounted anvil to accompany the gavel, subsequent names being engraved thereon. A number of the Sections and Chapters have been especially successful in capturing this award. Those groups which have won it more than once are: New York Section, seven times a winner; Cleveland Section, ten times including the Society's two trips to the West Coast, San Francisco, in 1939 and Pasadena in 1950; Southern California twice; Rocky Mountain Section twice; and New Orleans now a third time winner.

Golf Award

Another award hotly contested is the I.E.S. President's Cup, also known as the Law Trophy. Winner this year was Keith Nesbitt, Sachs Electrical Supply Co., Akron, Ohio, who also won in 1949 at French Lick.

This silver cup was presented to the Society by Clarence L. Law, President of the Society in 1923-1924. The trophy is placed in competition at each National Conference and on an 18-hole handicap basis. Winners' names are engraved each year. It was first won by George Ainsworth at the Briarcliff Convention in 1924.

Membership Awards

During ceremonies at the President's Banquet Thursday evening, cash awards were made by Richard G. Slauer, Membership Chairman, to winners of the Sections and Chapter Membership Contest. Awards were made to:

Group I — Northern California Section—1st prize
Southern California Section — 2nd prize
Group II — Twin City Section—1st prize
Southwestern Section—2nd prize
Group III — Rocky Mountain Section—1st prize
British Columbia Section—2nd prize
Rochester Section—3rd prize
Group IV — Arizona Chapter—1st prize
Oklahoma Chapter—2nd prize

Roaring Twenties Party

Anyone who figured roaring twenties clothes didn't do anything for them in their teens so couldn't do much now, learned better Monday night, September 8. This party was terrific. Roaringly terrific, and loads of fun. The Grand Ballroom was decorated for one huge "blind pig." Beaded, knee-length dresses, bandeaus and French heels turned the clock back 25 years, and dropped that many years of care from hundreds of shoulders.

The response was really tremendous, and was especially evident in the Section participation in Roaring Twenties skits. Winner was the New Orleans Section, with a sextette of Max Sennett bathing beauties in a cute routine. Throwing dignity aside to present this were: Cecil and Beth Paslay, Harbert and Jane Gregory, Jake and Elaine Gensburger, George Segel, M.C.

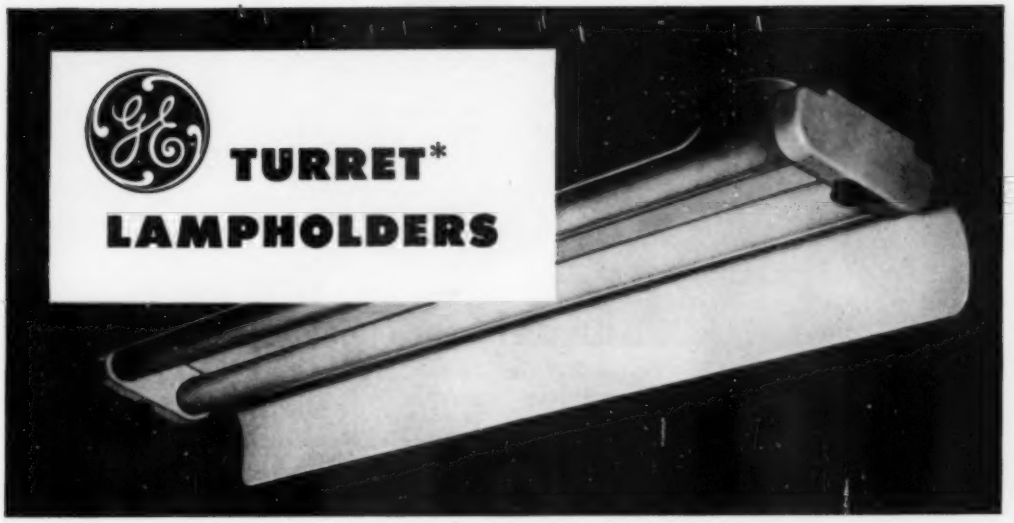
Twin City Section wowed the crowd with skits involving Red Grange (in a football suit about five feet broad), Andrew Volstead, et al. Their second place prize was taken by: Carl T. Bremicker, M.C. Louis J. Riegert, R. E. Olsen, W. T. Marek, R. D. Coons, J. O. Kvalsten, L. B. Paist, Lawrence Johnson, Dan Greene, John Williams, Lyman G. Hamilton, Wes Cotie and R. E. Steele.

Chicago Section revived Jack Asch and his Melody Boys, with a dance band so good everybody thought it was professional. Can a man be a good engineer and still play this good for a jazz band? Believe it or not, those hepcats were Dan Dunne, Jack Neuhauser, Joe Schneller, Allen Benjamin, Jim Freese, Les Schoenbrodt and Chet Thorsen, M.C.

More unsuspected talent was furnished by the Canadian entry, a roving group of troubadours with a terrific act. Bill Dalrymple (Toronto) is as good with an

(Continued on page 17A)

NEW DISPLAY featured I.E.S. publications at Chicago National Technical Conference. Convenient racks hold examination copies of various publications and order blanks are at hand. Display is executed in royal blue and gold, fully illuminated. This publications exhibit and its twin will be available for use by Sections at I.E.S. 1953 Regional Conferences.



Buyers look for these 4 features

1. EASY RELAMPING—To relamp G-E Turret lampholders, maintenance men simply push lamp against *either* spring-backed contact plate, slip other end in place.

2. TOUGH CONSTRUCTION—Steel Turret lampholders don't crack or break during relamping. Lamp and starter sockets take rough handling, are built for hard usage.

3. SURE GRIP—Spring-backed contact plates of Turret lampholders keep lamp pins fixed positively in position. No lamp safety-guards are required.

4. SMART, PRACTICAL SHAPE—Flush back of Turret lampholder makes neat, finished end-plate for fixture—eliminates need for extra trim. It permits mounting fixtures end-to-end for continuous lighting installations.

Turret lampholders offer all these features—plus the value of the General Electric name. So specify the brand in biggest demand—G-E Turret lampholders. For further data, write Section Q17-1087, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

*Registered Trade-mark of General Electric Company

THIS SIMPLE ACTION of Turret lampholders is fast becoming a must with users of fluorescent lighting. PUSH—and the lamp depresses the spring-backed socket. TWIST—and the pins are seated. POP—and into place goes the new lamp. The entire relamping operation can be done in a matter of seconds.

You can put your confidence in—

GENERAL ELECTRIC

For visual signals, for controlled distribution of light, for colored floodlighting effects, for intense concentration of light in beams or for uniform coverage of limited areas, Kopp lenses, color filters or roundels give the control and modification desired. Whether it be a traffic signal lens designed to concentrate the beam in the area where it is most easily perceived by motorists, or an indicator light to warn a housewife that one of her appliances is in operation —Kopp engineers can develop the most effective design, and Kopp craftsmen produce parts that are accurately made and dependably uniform in color, dimensions and transmission value.

Our well-staffed, modernly-equipped laboratory is prepared to study your requirements and develop designs that will meet your most exacting specifications.

KOPP GLASS

KOPP GLASS, Inc.
SWISSVALE, PA.

Where Credit Is Due

PUBLICITY STAFF at work in the press room, putting the daily bulletin to bed. Photo shows Burr Martin, Ernie Gallet, Bob Santmyers, and Jim Chambers. Other members of the Committee are out beating the next day's deadline.

COMMITTEE MEMBERS — National Technical Conference: Standing, W. R. Kaiser, Carl Jensen, C. B. Pederson, A. P. Larson, E. E. Elliott; seated, Charles Johnson, Lois Fetherston, Glenn G. Boyd. Complete listing of committee personnel can be found on page 22A.

(Continued from page 14A)

accordian as anything you'll hear, ditto Bus Allison with a banjo. This troup, in addition to those mentioned, included: Bert Wilson, M.C., Fred Mayberry, Max Strang and Wolfe Nottelman.

More Sections should have prepared for this party. They'll always regret it.

Ladies Program

The 257 ladies present at the conference participated fully in the fine program planned for them. Over 100 got up before daylight to attend the Don McNeil Breakfast Club radio program. Even more attended a get-acquainted coffee hour and "Know Chicago" tour. A fashion show and luncheon at the Wedgewood Room of Marshall Field's, luncheon at Kungsholm Restaurant of miniature opera fame, bridge parties and guided tours were only a few of the numerous events planned for them.

Lois Fetherston, Architect, as Chairman of the Ladies Program, was their gracious hostess throughout the week.

Committee Meetings

A lot of work was done behind scenes at the Edgewater Beach. Separate rooms were set for breakfast, luncheon and all-day to accommodate the numerous committee meetings held throughout the Conference. A partial list, as follows, indicates a great deal of I.E.S. work went forward that week. Some committees meeting were:

Committee	Chairman
Local Activities	
Illinois Room	A. H. Manwaring
Progress—Balmoral Room	T. C. Sargent
Papers—Illinois Room	R. M. Zabel
Nomenclature—Balmoral Room	D. M. Finch
Standards of Quality and Quantity	
Illinois Room	Willard Allphin
Civil Defense Lighting	
North Terrace	L. J. Schrenk
Daylighting	
North Terrace	R. L. Biesele, Jr.
Lighting Study Projects in Public Buildings and Private Institutions	
Illinois Room	R. S. Rogge
Lighting Study Projects in Industry	
Berwyn Room	A. A. Brainerd
Illumination Performance Recommendations	
Illinois Room	R. P. Teele
I.E.S. Research Fund Trustees and Executive Committee	
Room 188	A. F. Wakefield
National Technical Conference Committee	
Illinois Room	H. P. Steele
Street & Highway Lighting Committee	
American Room	F. D. Wyatt
School Lighting	J. M. Chorlton

Conference Bulletin

The French Lick Conference in 1949 started something, with a daily newspaper which has been a popular feature of every conference since. The Chicago Committee must have been packed with professionals. All news was hot, timely, accurate and amusing. Not a corny word in a single issue. All copies were quickly sought and frequently saved. Furthermore, it ran to a two page daily, ready so early the committee must have worked all night.

While a daily newspaper may not be earmarked for the archives, at least it gets wider and more immediate attention than other published material. This year's excellent edition was assembled and published by the Attendance and Publicity Sub-Committee under the Chairmanship of William R. Kaiser. For a clue to the professional talent (suspected all along) responsible for the professional results, see the credit column at the end of this report for the list of editors, high powered publicity men and

(Continued on page 19A)

Photo Credits . . .

Photographs for this issue and for the Scrap Book were taken by Gus Eckel, *Electrical Construction and Maintenance*, shown above in action; and by Bob Blatt *Electrical World*, both McGraw-Hill Publications.

HARD WORKING Chicago members registered 859 delegates, mostly in the first five minutes — or so it seemed.

HERE'S REAL BALLAST NEWS

A NEW LEAD-LAG BALLAST

- *AT SERIES BALLAST SIZES*
- *AT SERIES BALLAST ECONOMICS*
- *FOR ALL SLIMLINE LAMPS*

Lead-lag dependability in a series ballast "package" IS NEWS. This means longer lamp life, stroboscopic correction, reduced maintenance . . . PLUS the size, weight, price and power-loss advantages of a series ballast. This adds up to the *new* Westinghouse Lead-Lag ballast for all slimline lamps. Get the complete story on this new design in ballasts. Send for B-5614, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-04316

YOU CAN BE SURE... IF IT'S

Westinghouse

LIGHTING DIVISION

Edgewater Park, Cleveland, Ohio

(Continued from page 17A)

nd managers who comprised the committee.

INCIDENTAL INTELLIGENCE

A Past Presidents' luncheon was held during the Conference for 14 Past Presidents attending. Present at the luncheon were: Messrs. Sturrock, Goddard, Tayler, Hardacre, Wakefield, Williams, R. B. Brown, Jr., Willard Brown, Stair, Little, Magdsick, Harrison, Crampton and Stickney.

Displays in the Passagio were sponsored by I.E.S. Headquarters (Clayton E. Ellis in charge) and several I.E.S. Regions.

Milwaukee Section worked all week promoting their city for the 1955 Conference. Not official yet, though.

V.I.P.'s at the head table were:

President S. G. Hibben and Mrs. Hibben
Dr. John Aldington, who presented greetings at the opening session from our sister society in England, and Mrs. Aldington
Herbert Magdsick, 1952 Gold Medalist of I.E.S.
Hoyt P. Steele, Chairman National Technical Conference, and Mrs. Steele
Everett M. Strong, Vice-President of I.E.S., and Mrs. Strong
Homer Waring, Vice-President of I.E.S., and Mrs. Manwaring
Duncan M. Jones, Vice-President Elect of I.E.S., and Mrs. Jones
Clarence Pederson, Vice Chairman Conference Executive Committee, and Mrs. Pederson
Charles Laupp, Vice-President Midwestern Region, and Mrs. Laupp
Clarence Keller, General Secretary, and Mrs. Keller
R. A. Hartenstein, Treasurer, and Mrs. Hartenstein
C. L. Crouch, Technical Director, I.E.S.
Ruby Redford, Editor of ILLUMINATING ENGINEERING
Dax Hinckley, Executive Secretary of I.E.S.
Clayton E. Ellis, Advertising and Promotion Manager for the Society's Publications, and Mrs. Ellis

The Color Session Thursday afternoon, alone was worth any expense, time or travel to the Conference. These were all invited papers for which no preprints exist. A most worthwhile program for those present, however.

The Residence Lighting Forum Session Friday morning had meat for engineers and excellent material for visiting ladies as well.

The Illuminating Engineering Society extended official congratulations during the week to the American Society of Civil Engineers on the occasion of its centennial.

Three I.E.S. members addressed the Centennial of Engineering also convening in Chicago. President Hibben spoke Tuesday morning, bringing this Society's greetings. Willard C. Brown, Manager, Application Engineering Department, General Electric Co., addressed the Symposium Session on Communications at the 8th Street Theatre Friday morning. Mr. Browns topic was "100 Years of Light and Lighting — One of Mankind's Greatest Benefactors." R. L. Oetting presented a paper also on "100 Years of Light and Lighting" at the Centennial Session of the A.I.E.E. at the Congress Hotel, Wednesday morning. C. L. Crouch, I.E.S. Technical Director, addressed the A.S.M.E. on "Lighting as a Means of Promoting Safety" on September 8.

Aileen Page (General Electric) and Jan Reynolds (Sylvania) were both on television during the Conference. I.E.S. and its activities were well publicized by both these lighting specialists.

I.E.S. Regional Conferences, 1953

Canadian	Chateau Laurier Ottawa, Ont.	March 23-24
Southwestern	Hotel Baker Dallas, Tex.	April 12-14
Pacific Northwest	Multonomah Hotel Portland, Ore.	April 23-24
Midwestern	Minneapolis, Minn.	April 30 - May 1 (Tentative)
East Central	Hotel Lord Baltimore Baltimore, Md.	May 14-15
Southern	Sedgefield Inn Greensboro, N. C.	May 18-19
Great Lakes	Syracuse Hotel Syracuse, N. Y.	May 25-26

TECHNICAL PAPERS

For the record, the papers program consisted of the following:

Opening Session

Monday Morning — September 8

Presiding: Hoyt P. Steele, *Executive Vice-President*, Benjamin Electric Mfg. Co., Des Plaines, Illinois; *Chairman*, National Technical Conference.

Call to Order — Samuel G. Hibben, *President*, Illuminating Engineering Society.

Address of Welcome — Major Lenox R. Lohr, *President*, Museum of Science and Industry of Chicago, and President of the Centennial of Engineering.

Response — Samuel G. Hibben, *President*, Illuminating Engineering Society.

Report of the General Secretary — Clarence C. Keller, *Vice-President in Charge of Sales*, Holophane Company, Inc., New York, N. Y.

President's Address — Samuel G. Hibben, *Director of Applied Lighting*, Westinghouse Electric Corp., Bloomfield, N. J.

Our Society in 1952-53 — Everett M. Strong, *Professor*, Electrical Engineering, Cornell University, Ithaca, N. Y.

Presentation of Fellows in 1952 — *President* Samuel G. Hibben.

Awarding of I.E.S. Gold Medal to H. Herbert Magdsick, *Executive Engineer*, General Electric Co., Cleveland, Ohio — *President* Samuel G. Hibben.

Announcements by Chairman, Conference Executive Committee—Ralph Raymond, *General Sales Manager*, Commonwealth Edison Co., Chicago, Ill.

Technical Session — General

Monday Afternoon — September 8

Session Chairman — William P. Lowell, Jr., Sylvania Electric Products, Inc., Salem, Mass.
Discussion Organizer—Dean Farnsworth, U. S. Naval Submarine Base, New London, Conn.

1. Are We Confusing "Eyes" with "Vision" —D. B. Harmon, Austin, Texas.
2. Brightness Difference — Basic Factor in Suprathreshold Seeing — S. K. Guth, A. A. Eastman, R. C. Rodgers, General Electric Co., Cleveland, Ohio.
3. Silhouette Lighting of Small Diameter Wires — Willard Allphin, Sylvania Electric Products, Inc., Salem, Mass.
4. Brightness Discrimination Data for the Specification of Quantity of Illumination —H. R. Blackwell, University of Michigan, Ann Arbor, Mich.

Technical Session — Sources and Circuits

Tuesday Morning — September 9

(Parallel Sessions)

Session Chairman — Kirk M. Reid, General Electric Co., Cleveland, Ohio.
Discussion Organizer—George S. Evans, Westinghouse Electric Corp., Detroit, Mich.

Lamps and Lighting — A Vision of the Future — Dr. J. N. Aldington, B.Sc., Ph.D., F. Inst. P., F.R.I.C., & F.I.E.S., A.M.I.E.E., Siemens Electric Lamps & Supplies Ltd., Preston, Lancashire, England.

5. Low Pressure Mercury Discharge — III — George Meister and T. H. Heine, Westinghouse Electric Corp., Bloomfield, N. J.
6. The Physical Basis for Some Aspects of Fluorescent Lamp Behavior — E. F. Lowry, Sylvania Electric Products, Inc., Salem, Mass.
7. Evaluation of Color Rendition by Fluorescent Lamps — An Exploratory Study — A. C. Barr, C. N. Clark, J. Hessler, General Electric Co., Cleveland, Ohio.

Technical Session — Sources and Circuits

Tuesday Afternoon — September 9

(Parallel Sessions)

Session Chairman—Louis E. Barbrow, National Bureau of Standards, Department of Commerce, Washington, D. C.
Discussion Organizer — Ellery H. Raddin, Champion Lamp Co., Lynn, Mass.

13. Reflectorized Mercury Lamps and Their Industrial Applications — E. B. Noel, E. A. Linsday, General Electric Co., Cleveland, Ohio.
14. A New Lead-Lag Ballast for Discharge Lamps — C. H. Burns, H. E. Bachman, Westinghouse Electric Corp., Cleveland, Ohio and Bloomfield, N. J.
15. New Fluorescent Lamp and Ballast Design for Rapid Starting—A. E. Lemmers, W. W. Brooks, General Electric Co., Cleveland, Ohio.
16. Characteristics and Applications of High-Frequency Fluorescent Lighting — J. H. Campbell, H. E. Schultz, D. D. Kershaw, General Electric Co., Cleveland, Ohio.

(Continued on page 20A)

DON'T FORGET — It's New York in '53. Headquarters staff will welcome visitors. A. D. Hickley, Executive Secretary; Ruby Redford, Editor; C. L. Crouch, Technical Director, and C. E. Ellis, Advertising and Promotion Manager, wear welcoming grins.

(*Continued from page 19A*)

Technical Session — Daylighting
Tuesday Morning — September 9
(Parallel Sessions)

Session Chairman — John O. Kraehenbuehl, University of Illinois, Urbana, Ill.
Discussion Organizer — W. Clifton Randall, Detroit Steel Products Co., Detroit, Mich.

8. The Attainment of Quality Daylighting in School Classrooms — R. A. Boyd, University of Michigan, Ann Arbor, Mich.
9. A Lumen Method of Daylighting Design — R. L. Biesele, Jr., Southern Methodist University, Dallas, Texas; W. J. Arner, Southern Methodist University and Research Department, Libbey-Owens-Ford Glass Co., Toledo, Ohio; E. W. Conover, Southern Methodist University and Research Department, Detroit Steel Products Co., Detroit, Mich.
10. The Importance of Ground Reflection in Daylighting — J. W. Griffith, Southern Methodist University, Dallas, Texas; O. F. Wenzler, Libbey-Owens-Ford Glass Co., Toledo, Ohio; E. W. Conover, Southern Methodist University and Research Department, Detroit Steel Products Co., Detroit, Mich.
11. Controlling and Redirecting Daylight by Means of Louvers — H. S. Hull, University of Michigan, Ann Arbor, Mich.
12. A New Daylighting Survey Technique Utilizing a Photographic Recorder and Physical Brightness Meter — W. H. Bullhartz, H. F. Kingsbury and R. W. McKinley, Pittsburgh Corning Corp., Port Allegheny, Pa. and Pittsburgh, Pa.

Technical Session — Outdoor Lighting
Tuesday Afternoon — September 9
(Parallel Sessions)

Session Chairman—Francis D. Wyatt, Chicago Park District, Chicago, Ill.
Discussion Organizer — Dana W. Bowden, Westinghouse Electric Corp., Cleveland, Ohio.

17. Pavement Brightness Measurements — D. M. Finch, University of California, Berkeley, Cal.; R. B. Marshelmer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Cal.
18. Techniques for Photography of Lighted Streets — T. Knowles, D. A. Toenjes, General Electric Co., Cleveland, Ohio.
19. Some Photographic Methods Applied to Photometry — Charles Marsh, Pennsylvania State College and Consultant, Westinghouse Electric Corp., State College, Pa.
20. Standard Practice of Street and Highway Lighting — Street and Highway Lighting Sub-Committee, C. H. Rex, Chairman, General Electric Co., West Lynn, Mass.
21. The Kinorama as an Evaluator in Aviation Lighting — F. C. Breckenridge, National Bureau of Standards, Department of Commerce, Washington, D. C.

Technical Session — General
Wednesday Morning — September 10

Session Chairman — G. W. Beals, The Miller Company, Meriden, Conn.
Discussion Organizer — D. M. Finch, University of California, Berkeley, Cal.

22. The Zonal Method of Computing Coefficients of Utilization and Illumination on Room Surfaces — J. R. Jones, J. J. Neidhard, Westinghouse Electric Corp., Bloomfield, N. J. and Cleveland, Ohio.
23. Control and Measure of Directional Flux at the Task — George F. Wakefield, F. W. Wakefield Brass Co., Vermilion, Ohio.
24. Visibility of School Tasks — J. M. Ketch, C. J. Allen, General Electric Co., Cleveland, Ohio.
25. Cost and Comfort Appraisal of Industrial Lighting Systems — G. J. Taylor, R. D. Bradley, Day-Brite Lighting, Inc., New York, N. Y. & St. Louis, Mo.

Lighting Service Forum
Wednesday Afternoon — September 10

Presiding — Lee E. Tayler, Detroit Edison Co., Detroit, Michigan.; *Chairman*, Lighting Service Committee.

"MY MOST INTERESTING LIGHTING JOB CONTEST"
(Judging for National Awards)

REGIONAL AWARD WINNERS:

East Central Region
Hugh S. James, Pittsburgh Section, Duquesne Light Co., Pittsburgh, Pa., "The Relighting of a Syrian Mosque."

Great Lakes Region
Earl R. Domoney, Michigan Section; Consumers Power Co., Saginaw, Mich.; "The Relighting of a Church."

Midwestern Region
Carl H. Johnson, Chicago Section, Johnson & Johnson, Engineers Architects, Chicago, Ill.; "Remodeling the Banking Floor for Bell Savings and Loan in Chicago."

Northeastern Region
H. Neil McIntyre, New England Section; General Electric Co., Lynn, Mass.; "Fluorescent Floodlighting for an Airport."

South Pacific Region
*Roy E. Bevan, Southern California Section; Southern California Edison Co., Beverly Hills, Cal.; "Lighting for Beverly Vista Community Church."

*Paper to be read by Lt. Col. J. W. Howard, U.S.A.F.

Progress Report
Wednesday Evening — September 10

Presiding — Theodore C. Sargent, Sylvania Electric Products, Inc., Salem, Mass.; *Chairman, Committee on Progress.*

PROGRESS COMMITTEE SESSION

Report of Lighting Progress 1951-52.

Technical Session — Applications
Thursday Morning — September 11

Session Chairman—Howard L. Wright, Curtis Lighting of Canada, Ltd., Toronto, Ont.
Discussion Organizer—Ray P. Teele, National Bureau of Standards, Department of Commerce, Washington, D. C.

26. Tests Aimed at Realistic Maintenance Factors—R. L. Oetting and J. W. Tuttle, General Electric Co., Cleveland, Ohio.
27. Time Versus Luminous Ceilings — D. E. Spencer, University of Connecticut, Storrs, Conn.; L. F. Martin, Martin Electric Products, Inc., Somerville, Mass.
28. Positioning of Directionally Adjustable Luminaires — Merle E. Keck, Westinghouse Electric Corp., Cleveland, Ohio.
29. Structural Lighting in a Modern Home—Aileen M. Page, General Electric Co., Cleveland, Ohio.
30. Developments in Submarine and Small Vessel Lighting—Dean Farnsworth, U. S. Naval Submarine Base, New London, Conn.

Technical Session — Color
Thursday Afternoon — September 11

Session Chairman — Roy A. Palmer, Duke Power Co., Charlotte, N. C.

*The Expressiveness of Color — Ralph M. Evans, Eastman Kodak Co., Rochester, N. Y.

Light, Sound and Motion — Films.

*Color Television — C. M. Hoyler, R.C.A. Laboratories, Princeton, N. J.

*Invited Papers.

Closing Business Session

Presiding Chairman — Hoyt P. Steele, Executive Vice-President, Benjamin Electric Manufacturing Company, Des Plaines, Ill.; *Chairman*, National Technical Conference Committee.

1. Report of the Committee on the President's Address.
2. Report of the Resolutions Committee.

Technical Session — Residence Lighting Forum
Friday Morning — September 12

Presiding Session Chairman — Jan Reynolds, Sylvania Electric Products, Inc., New York, N. Y.

Chairman — Residence Lighting Forums Committee.

How Do You Look — A Study of Pier Mirror Illumination — Edith L. Buchholtz, Westinghouse Electric Corp., Bloomfield, N. J.
An Interior Designer Looks at Lighting — Marianne Willisch, Interior Designer, Chicago, Ill.
A Famous Host Remodels His Kitchen — Myrtle Fahsbender, Westinghouse Electric Corp., Bloomfield, N. J.

(*Continued on page 22A*)

World's Largest Airport Terminal Building Features GARCY Custom-Designed Fixtures and New Lighting Application Techniques

Design of the Terminal Building was by Theodore Eichholz (deceased), under the guidance of Allegheny County Department of Aviation with the capable supervision of Director John B. Sweeney and Chief Engineer Edward G. Messner and with the assistance of Consulting Architect Joseph Hoover. James Paul Warner, consulting electrical engineer, is responsible for the airport's entire electrical system. The lighting facilities for this project were installed by Daniels Electric Equipment Co. and The Howard P. Foley Co. The distributor was Graybar Electric Co., Inc.

The unusual fixture which occupies the center of the rotunda ceiling is an adaptation of Garcy's No. 8440 Louverall. Note the customized treatment of the louverall area . . . conforming to the converging lines of the building which forms the segment of a circle. A wide variety of other Garcy stock and custom-design fixtures were utilized to meet the unusual architectural and lighting requirements involved. No matter how complex or unique your lighting problems may be, your nearby Garcy Representative can help you solve them efficiently, satisfactorily, economically.

UPPER RIGHT

View of Rotunda showing specially designed louverall area conforming to radial design of building. Continuously mounted troffers also follow this design.

LOWER RIGHT

View of South Dock showing variety of Garcy lighting equipment used in project. Modular and continuous louverall sections are shown at left, while individually mounted louvered aluminum troffers are used in center. Cove lighting is provided by Garcy Adda-Strip.

GARCY

Write for copy of new Garcy Lighting Equipment Catalog

GARDEN CITY PLATING & MFG. CO. 1760 N. Ashland—Chicago 22, Illinois

(Continued from page 20A)

Lighting of a Recreation Room in an Average Income Home—Katherine Goodall, Philadelphia Electric Co., Philadelphia, Pa.
A Luminous Ceiling Installation in a Bathroom — Thomas Smith Kelly, Lighting Consultant, New York City, N. Y.
Bright Future — A Color Film — Eugene W. Commery, General Electric Co., Cleveland, Ohio.

Who's Who

The smoother the conference (and this was smooth) the more one may be sure many men and women worked throughout the conference and for many months previous. Credit is due the following for a seemingly effortless operation:

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Francis D. Wyatt

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Deadline January 1 for I.E.S. Gold Medal Nominations

January 1 is the closing date for receipt of nominations for the I.E.S. Gold Medal. Nominations for this, the highest award of the Society, are invited from all members for consideration by the Medal Award Committee.

The I.E.S. Gold Medal is awarded to give recognition to meritorious achievement which has conspicuously furthered the profession, art or knowledge of illuminating engineering. The following points should be observed in making nominations for the Award.

(1) Candidates need not be members of the Society, nor citizens of the United States and Canada. Nominations may be made at any time by any member of the Society by presenting to the General Secretary at Society Headquarters the name of the individual whose accomplishments in his field are deemed worthy of such recognition — in the field of engineering, design, applied illumination, optics, ophthalmology, lighting research, education, or administration and management.

(2) In order for a candidate to be considered for the award of a given year, a letter requesting consideration of the proposed candidate shall be delivered at the General Office of the Society before January 1 of that year.

(3) Nominations and records on file in the General Office from previous years, as reviewed and referred to the next year's committee by the previous Medal Award Committee, will be given consideration along with any new nominations.

TV Studio Lighting Subject of Two-Day Clinic

The improvement of television pictures through the better lighting in TV studios is the subject of two two-day Television Studio Lighting Clinics being held at the General Electric Lighting Institute, Cleveland, the week of October 13.

Sessions at the clinics are conducted in a model studio, built in the Institute's auditorium. Television cameras are used to take pictures of actual lighting situations and monitors show how the camera sees the sets and performers.

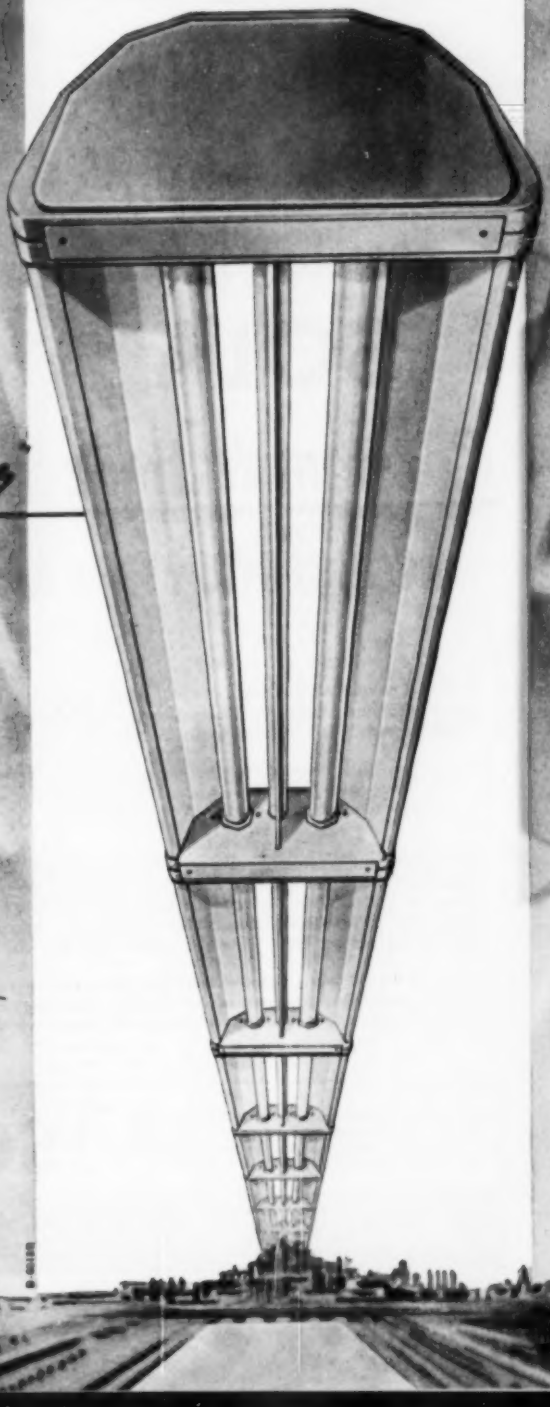
The first day's program consists largely of discussions of the tools involved in studio lighting—the various light sources available and their selection, camera tubes and their characteristics and adjustments. The second day will be devoted to the aspects of selecting and installing lighting equipment, the control of lighting and the integration of light with other studio requirements.

(Telecast continued on page 25A)

now, a new high in seeing comfort

through sensationally-increased

UPWARD LIGHT...



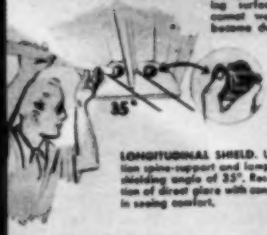
Now, approximately ¾ of light is directed UPWARD through a completely new, precedent-shattering concept of lighting unit design! The new Benjamin "Task-Master" is the modern solution to the brightness ratio problem. By combining greater upward flow of light with a new high of 35° in lamp shielding, "Task-Master" doubles, even triples, present standards for industrial seeing comfort. In addition to sensationally-increased UPWARD light and lamp shielding, "Task-Master" features revolutionary new, easier methods of installation and maintenance, such as those illustrated below. Send for FREE "Task-Master" Bulletin, giving further details. Write for Bulletin AD 5906. Benjamin Electric Mfg. Co., Dept. I, Des Plaines, Illinois.

BENJAMIN Task Master

Sold Exclusively through Electrical Distributors

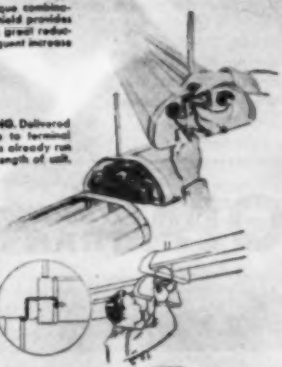
DETACHABLE REFLECTORS are hinged to make possible easier, more thorough cleaning right on the fixture. They may also be detached and cleaned away from the unit. Available with sliding hangers, as shown.

"LIFE-TIME" PORCELAIN ENAMEL. Reflectors and shield are covered with genuine Porcelain Enamel, which is unsurpassed as a reflecting surface because it cannot wear, scratch or become dull.



"SPRINGLOK" LAMPHOLDERS are standard equipment. These rugged, all-metal, lifetime lampholders facilitate lamping and relamping through patented spring design.

LONGITUDINAL SHIELD. Unique combination spine-support and lamp shield provides shielding angle of 35°. Result: great reduction of direct glare with consequent increase in seeing comfort.

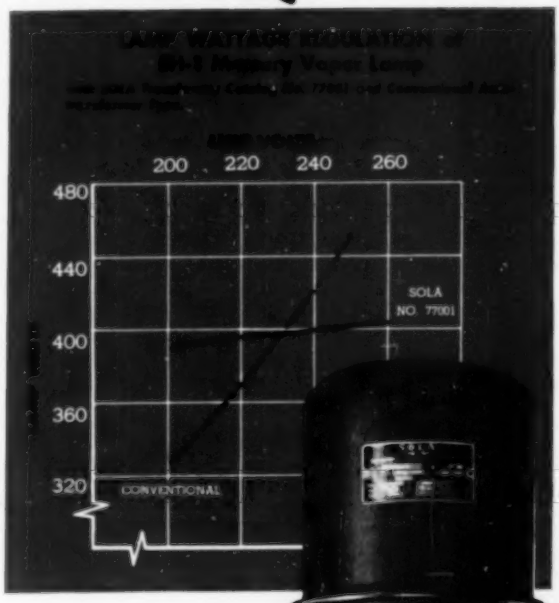


PRE-WIRED—NO WIRE SPLICING. Delivered with all connections made up to terminal block. Branch-circuit wire comes already run through spine support, entire length of unit.

SPECIAL "HOOK-UP" DESIGN makes it possible for the installer to temporarily hang one unit on another while connecting the jumper wires to opposite terminal blocks.

extended lamp life

for Mercury Vapor Lamps operating from SOLA Constant Wattage Transformers



A direct relationship exists between proper input voltage and mercury vapor lamp efficiency and life. The following facts about this relationship were recently published in leading trade journals:

1. *Lamp life is shortened through overheating from 5% overvoltage.*
2. *Mercury vapor lamps extinguish with 15% undervoltage.*
3. *Light output is cut 15 to 25% with 10% undervoltage.*

Sola Constant Wattage Transformers continuously and automatically supply constant wattage within ±2% regardless of line voltage fluctuations as great as ±15%. This new application of the patented Sola Constant Voltage Principle assures operation of mercury vapor lamps under the same conditions for which they were designed, resulting in:

1. *Savings of lamp replacement cost, labor expense and inconvenience of relamping.*
2. *Dependability, since lamps will not extinguish until voltage drops to 75 volts.*
3. *Maintained light output constant within ±3% even with ±15% voltage fluctuation.*

OUTDOOR TYPE CAT. NO. 77001 IS ILLUSTRATED HERE.

Made under one or more of the following U. S. patents: 2,143,745; 2,212,198; 2,346,621; and Pats. Pend.

Electrical and mechanical specifications and other benefits of regulated mercury vapor lamp operation are described in a bulletin now available. Write for your copy of BULLETIN C-MV-166.

SOLA *Mercury Vapor Lamp* **TRANSFORMERS**

(Continued from page 22A)

IT SEEMS TO ME

Moving Striations In Fluorescent Lamps

The characteristics of moving striations in fluorescent lamps run on d-c have been discussed in the literature[1] much more than a-c characteristics. Fig. 1 is a picture[2] taken with the camera focused on a 40-watt fluorescent lamp discharge (no phosphor). The film in this camera is moved at right angles to the discharge axis so that the movement of inhomogeneous regions such as moving striations can be studied. The discharge axis is horizontal in this picture so that time is vertical. The Faraday dark space separates the cathode glow from the positive column. It is at the left in the first half cycle; at the right in the second. This picture is from a short length of film, one cycle long, taken from a much longer film of identical sequences. The discharge had been running for some time. The eye, of course, can not see even the 120-cycle darkening between half cycles. As in the d-c case the striations are a low current phenomenon, therefore occurring only early in the cycle in standard 40-watt operation. The striations move toward the cathode although they are obviously created by electrons from the cathode. The fact that the cathode, rather than

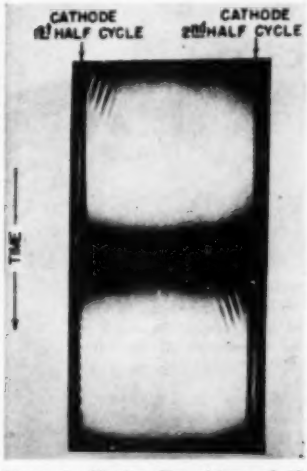


Figure 1. Moving film picture of 40-watt fluorescent lamp discharge (no phosphor) running on standard 420 milliampere ballast. Axis of lamp is horizontal and extends from one arrow to the other. One complete cycle of operation is shown.

the anode, causes striations has escaped experimenters studying striations on d-c.

A picture similar to this showing the first one-quarter of a cycle appeared in this publication.[3] That picture was taken using a rotating mirror and showed, in addition, pulsations in the light throughout the full length of the discharge. They would be horizontal bars in the picture presented here. A resistive ballast was used by Culp[3] while a standard inductive ballast was used for Fig. 1. In studies using d-c, it was discovered that high resistance ballasts of 10,000 ohms eliminated these pulsations. Thus it seems that the pulsations occur only in circuits which have lower ability to filter or regulate the current fluctuations. The changing intensity of the discharge is probably caused by a transient adjustment of current through the positive column. It is not known whether an increase in intensity spreads from the anode region or the cathode region. It is difficult to imagine, however, that the whole column becomes bright at the same time. With this in mind it seems plausible to classify the pulsation as high speed striations.

HOWARD L. STEELE, JR., *Westinghouse Electric Corp., Lamp Division, Research Department, Bloomfield, N. J.*

1. Kenty, C.: *Phys. Rev.*, Vol. 80, pp. 95-96 (October 1, 1950).
Steele, H.: *Phys. Rev.*, Vol. 82, p. 571 (May 15, 1951).
2. Part of paper (F7) presented to Gaseous Electronics Conference, Mellon Institute, Pittsburgh, Pa., November 1949, entitled "Fast and Slow Moving Striations in a Mixture of Mercury and Inert Gases."
3. Culp, W.: "Noise in Gaseous Discharge Lamps," ILLUMINATING ENGINEERING, Vol. XLVII, No. 1, p. 37 (January 1952). Fig. 4.

LIGHTING CALENDAR

Society Events

October 9, 1952 — Meeting of I.E.S. Council, New York, N. Y.

December 11, 1952—Meeting of I.E.S. Council, New York, N. Y.

March 23-24, 1953—Canadian Regional Conference, Chateau Laurier, Ottawa, Ont.

April 13-14, 1953 — Southwestern Regional Conference, Hotel Baker, Dallas, Texas.

April 23-24, 1953—Pacific Northwest Regional Conference, Multnomah Hotel, Portland, Ore.

April 30 - May 1, 1953 — Midwestern Regional Conference, Minneapolis, Minn. (Tentative)

May 14-15, 1953 — East Central Regional Conference, Hotel Lord Baltimore, Baltimore, Md.

May 18-19, 1953 — Southern Regional Conference, Sedgefield Inn, Greensboro, N. C.

May 25-26, 1953 — Great Lakes Regional Conference, Syracuse Hotel, Syracuse, N. Y.

September 14-18, 1953 — Illuminating Engineering Society, National Technical Conference, Commodore Hotel, New York, N. Y.

Industry Events

October 6-8, 1952 — National Association of Electrical Distributors, Fall Meeting of the Pacific Zone, Hotel del Coronado, Coronado, Calif.

October 13-17, 1952 — Fall General Meeting, American Institute of Electrical Engineers, New Orleans, La.

October 20-21, 1952 — National Farm Electrification Conference, Hotel Statler, Detroit, Mich.

October 20-24, 1952 — 40th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 10-13, 1952 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 17-19, 1952 — 39th National Foreign Trade Convention, Waldorf-Astoria Hotel, New York, N. Y.

November 19, 1952 — 34th Annual Meeting, American Standards Association, Waldorf-Astoria Hotel, New York, N. Y.

November 30 - December 5, 1952 — Annual Meeting, The American Society of Mechanical Engineers, Statler Hotel, New York, N. Y.

January 19-22, 1953 — Plant Maintenance Show, Public Auditorium, Cleveland, Ohio.

January 19-23, 1953 — Winter General Meeting, American Institute of Electrical Engineers, New York, N. Y.

January 26-29, 1953—American Society of Heating and Ventilating Engineers, 59th Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.

March 9-13, 1953 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

March 30 - April 2, 1953 — Annual Sales Conference, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.

Week of May 24, 1953 — 45th Annual Convention, National Association of Electrical Distributors, Stevens Hotel, Chicago, Ill.

June 1-4, 1953 — 21st Annual Convention, Edison Electric Institute, Atlantic City, N. J.

June 29 - July 3, 1953 — Summer General Meeting, American Institute of Electrical Engineers, Atlantic City, N. J.

August 18-21, 1953 — Pacific General Meeting, American Institute of Electrical Engineers, Vancouver, B. C.

September 21-26, 1953 — 25th Jubilee Meeting, International Association of Electrical Inspectors, Edgewater Beach Hotel, Chicago, Ill.

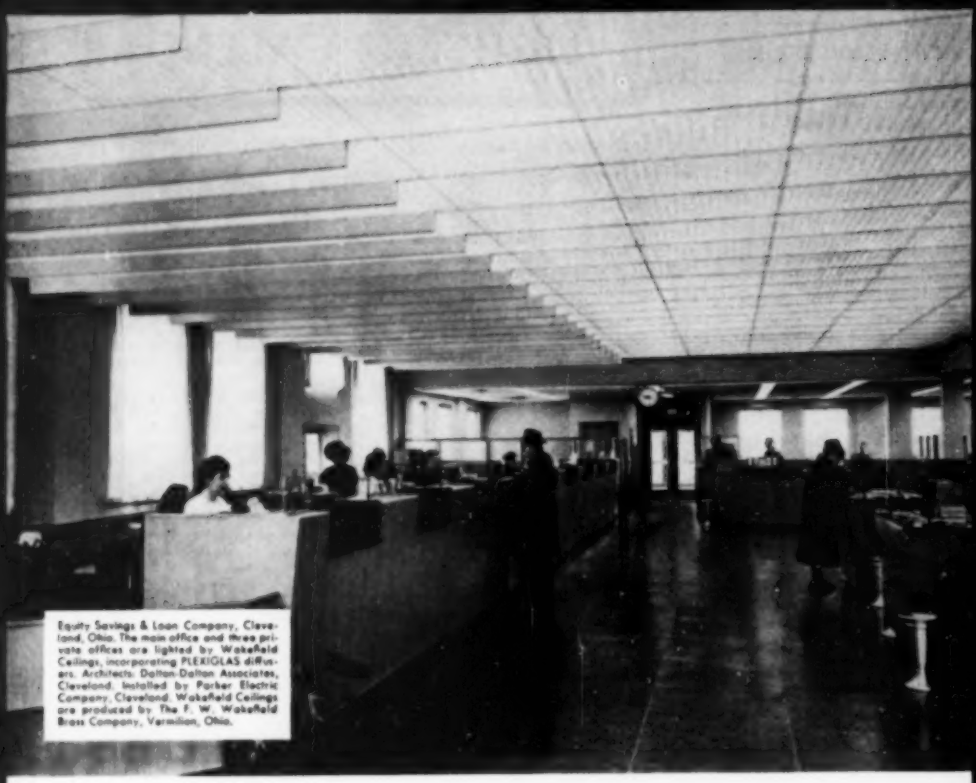
September 23-25, 1953 — Annual Meeting, Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont.

October 19-23, 1953 — 41st National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 9-12, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

January 18-22, 1954 — Winter General Meeting, American Institute of Electrical Engineers, New York, N. Y.

March 8-11, 1954 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.



Equity Savings & Loan Company, Cleveland, Ohio. The main office and three private offices are lighted by Wakefield Ceilings, incorporating PLEXIGLAS diffusers. Architects: Dalton-Dalton Associates, Cleveland. Installed by Parker Electric Company, Cleveland. Wakefield Ceilings are produced by The F. W. Wakefield Brass Company, Vermilion, Ohio.

Lighting . . . Air Diffusion . . . Sound Control . . .

Combined in a Luminous Ceiling

The Wakefield Ceiling shown above, with its corrugated PLEXIGLAS diffusing panels, combines three functions in a single installation.

• Mounted wall to wall beneath fluorescent tubes, the acrylic plastic panels provide high level, low brightness, evenly diffused illumination.

• Conditioned air from the space above the luminous ceiling is delivered into the room through the openings at the edges of the corrugated diffusers. The multiple openings insure an even distribution of air, with elimination of drafts on customers and employees.

• The simple framework for the PLEXIGLAS also supports acoustical baffles which absorb sounds from the work area.

This Wakefield method of combining air diffusion and sound control with *the best* in lighting—using PLEXIGLAS acrylic plastic—can reduce building construction and operation costs. In addition there is the advantage of duct-free, fixture-free appearance.

We will be glad to send you details about the installation shown above, and tell you how PLEXIGLAS may solve *your* lighting problem.

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Heart of America Section — W. L. Stiers

Mexico Chapter — to be announced

Mississippi Chapter — to be announced

New Mexico Chapter — Stanley Bazant, Jr.

Ohio Valley Section — R. J. Schulte

Oregon Section — Ray W. Preston

Ottawa Chapter — Major G. D. Mills

Toronto Section — F. C. Mayberry

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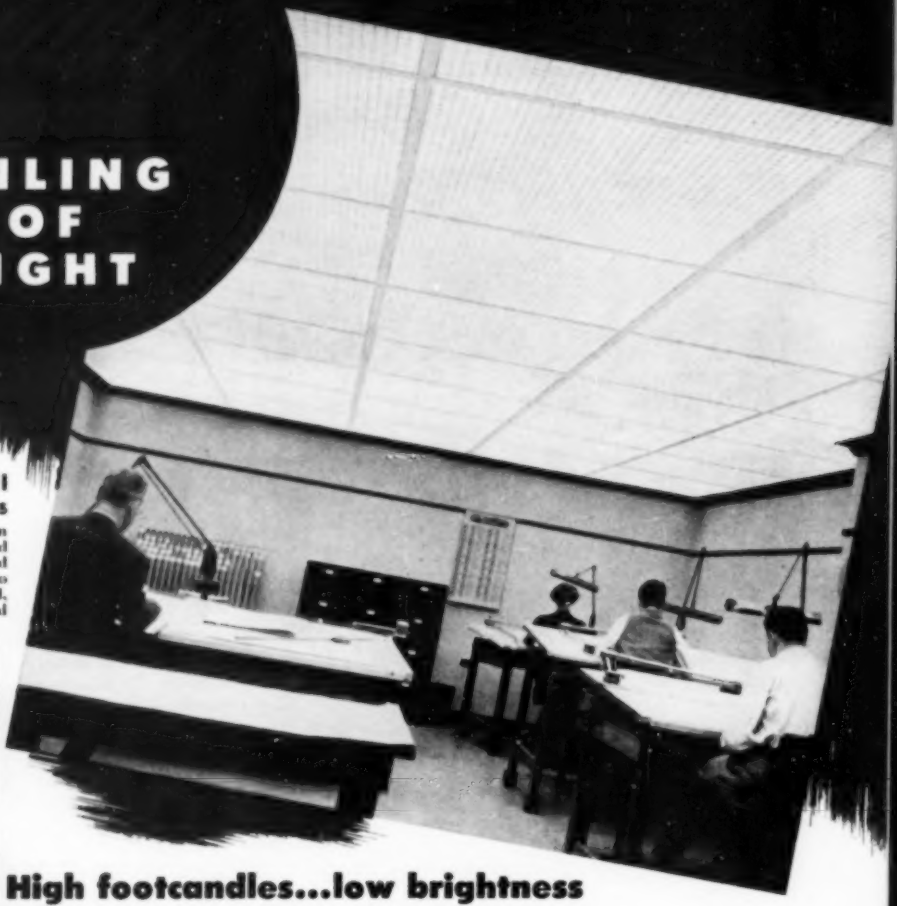
CEILING OF LIGHT



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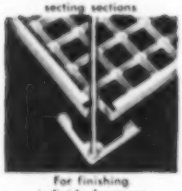

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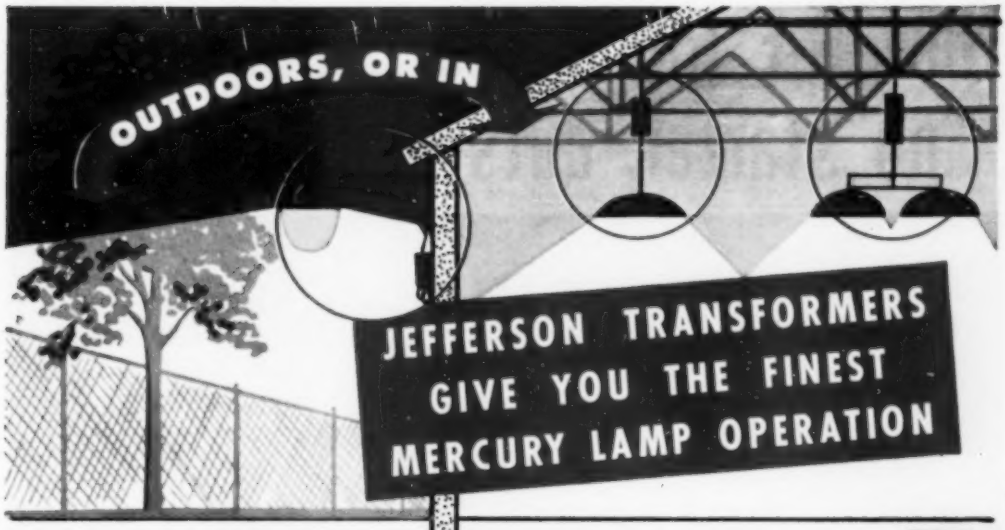

JEFFERSON TRANSFORMERS GIVE YOU THE FINEST MERCURY LAMP OPERATION

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The finest transformers for outdoor operation of all H-1 400 watt mercury lamps. From core and coil to seamless hot-dipped galvanized case, every modern design and construction feature has been built in for longest transformer life and maximum lamp performance.

Every Jefferson Transformer is engineered to the highest quality standards. All are in deep drawn *weatherproof* cases for years of positive protection against the elements. Each has *all* the extra value features found *only* in Jefferson Transformers.

Streamlined hot-dipped galvanized case sheds water like a duck. No seams, no cracks, no place for moisture to seep in. Welded bracket has keyhole slot for easy mounting. Dura-Gray harmonizing finish for modern, attractive installations.

Large handhole gives easy access to color-coded tagged leads. Correct installation is quick, positive.

Patented Jefferson Adaptor converts wall and post mounting transformers to pole top units in minutes. Transformer stacks can be cut drastically as one type transformer can be mounted wherever needed—wall, post, or pole-top with an adaptor.

Universal Adaptor fits any pole top from 2-1/2" to 4" O.D. — fills every need. It's inexpensive, easy to mount. Provides a solid, weatherproof base for the transformer. Comes fully equipped with outlet fittings.

FOR INDOOR SERVICE

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Mercury and incandescent lamp wiring facilities are provided at both ends in ample wiring compartments. Leads are color-coded and tagged. One-half and ¾" knockouts are provided in both sides of each wiring compartment and in both end plates for trouble free wiring. Condenser is mounted in a separate compartment for efficient cooling and maximum life.

●

Jefferson Single Lamp Transformers give you every vital feature for top-notch lamp operation and economy. Press-fit riveted core, double varnished core and coil assembly, three primary taps (not just two), easy mounting brackets, and incandescent as well as mercury lamp leads out of both ends are a few of the outstanding Jefferson features. You get all these extra values in Jefferson Transformers, yet they cost no more than ordinary transformers.

Specify Jefferson for the best operation of every mecury lamp installation. New 16-page illustrated Bulletin 521-5 gives complete data on H-1 400 watt models as well as the new Jefferson Transformers for H-12 and H-15 1000 watt mercury lamps.

JEFFERSON ELECTRIC COMPANY
BELLWOOD, ILLINOIS

TWO-LAMP TRANSFORMER

SINGLE LAMP TRANSFORMER

Jefferson Transformers

New G-E Rapid Start lamp needs no starter, cuts maintenance

IN THE NEW RAPID START lamp circuit G-E has been able to eliminate the starter required in standard lamps to pre-heat the cathode. For that reason, maintenance is even easier, more economical than before.

This new General Electric *Rapid Start* lamp was made possible by two G-E developments: an improved triple-coil cathode that replaces the double coil in standard fluorescent lamps, and a *Rapid Start* ballast. Together, they give General Electric *Rapid Start* lamps almost instant starting and smooth, simple operation.

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Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada *L. E. Messinger*

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill. *W. F. Bolle*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Louisiana Electric Co., Inc.
P.O. Box 1096, Lafayette, La. *J. R. Gaugler*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas *James M. Williams*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio *J. R. Hartman*

City of Burbank, California Public Service Dept.
174 W. Magnolia Boulevard, Burbank, Calif. *J. H. McCambridge*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *L. W. Grayson*

City of Riverside Electric Light Dept.
P.O. Box 826, Riverside, Calif. *A. J. Kennedy*

City of Seattle, Dept. of Lighting
1015 Third Ave., Seattle 4, Wash. *P. C. Spowart*

City of Tacoma, Light Division
402 City Hall, Tacoma 2, Wash. *Roy H. Weston*

The Cleveland Electric Illuminating Co.
75 Public Square, Cleveland 1, Ohio *R. C. Hienton*

Clyde Porcelain Steel Corp.
2211 Birdseye St., Clyde, Ohio *W. F. White*

Colonial Premier Corp.
466 W. Superior St., Chicago 10, Ill. *Richard Weis*

Columbia Electric & Mfg. Co.
Box 2180, Spokane, Wash. *Walter A. Toly*

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill. *Michael R. Fine*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *Ralph G. Raymond*

Compco Corporation
2251 W. St. Paul, Chicago 47, Ill. *Lawrence H. Wrobel*

Connecticut Light & Power Co.
P. O. Box 2010, Hartford 1, Conn. *Robert G. Ely*

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *C. Miller*

Consolidated Gas, Elec. Light & Power Co. of Baltimore
100 W. Lexington St.,Baltimore 1, Md. *M. C. Albrittain*

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power District
1452 25th Ave., Columbus, Nebr. *W. H. Sinke*

Continental Electrical Construction Co.
3540 Southport Ave., Chicago 13, Ill. *Leo W. Witz*

Corning Glass Works
Corning, N. Y. *A. S. Tyler*

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave.,Leaside, Toronto 12, Ont. *H. L. Wright*

Cutler Light Manufacturing Co.
2026-28 N. 22d St., Philadelphia 21, Pa. *Robert T. Cutler*

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del. *W. A. F. Pyle*

Dept. of Water & Power, City of Los Angeles, Bur. of Power & Light
Box 3669, Terminal Annex, 207 So. Broadway, Los Angeles 54, Calif. *William S. Peterson*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Taylor*

Detroit Electrical Contractors Association
627-628 Hotel Book Cadillac, Detroit 26, Mich. *Carl J. Schoeninger*

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich. *W. Clifton Randall*

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

E. I. duPont de Nemours & Co., Inc. Polychemicals Dept.
Wilmington 98, Del. *R. E. Leary*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duray Fluorescent Mfg. Co.
3552 N. Pulaski Rd., Chicago, Ill. *Ludwig Dannenberg*

Duro Test Corp.
2521 Hudson Blvd., North Bergen, N. J. *James L. Cox*

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

(Continued on page 36A)

(Note: Names of Official Representatives appear in italics.)

5 REASONS WHY

(Continued from page 35A)

East Side Metal Spinning & Stamping Corp.
1301 Elizabeth Ave., W., Linden, N. J.
M. A. Kremer

Ebosco Services, Inc.
2 Rector St., New York 6, N. Y. *P. D. Brooks*

Efengee Electrical Supply Co.
949 W. Chicago Ave., Chicago 22, Ill. *Lee Mirus*

Electrical Information Publications, Inc.
29 N. Carroll St., Madison, Wis.
Lewis E. Johnston

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York 21, N. Y.
W. F. Little

Electric Supply Corporation
701 W. Jackson Blvd., Chicago 6, Ill.
G. M. Marks

Electro Manufacturing Corp.
2000 W. Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada
John Isenman

Electron Corp.
5100 South Santa Fe, Littleton, Colo.
Milt Heisner

Englewood Electrical Supply Co.
5801-09 So. Halsted St., Chicago, Ill. *Ray O'Leary*

Esty Manufacturing Company
1251 W. Monroe St., Chicago 6, Ill.
Ben Trossman

Ever-Brite Products Corp.
1629 Milwaukee Ave., Chicago 47, Ill.
Jack Lipschultz

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Florida Power & Light Co.
Box 5100, Miami 30, Fla. *C. B. Vick*

Fluorescent Equipment & Mfg. Co.
2105 Cowan Ave., Cleveland 4, Ohio
Leonard S. Freeman

Fluorescent Fixtures of Calif.
5520 18th St., San Francisco 10, Calif.
Ernst O. Anders

Fluoro-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Framburg & Co.
3520-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The Franco Mfg. Co.
10525 Berea Rd., Cleveland 2, Ohio *J. H. Mayne*

The Frankolite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service, Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660, Oakland 4, Calif.
T. E. Rinehart

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y.
Theo. J. Brassel, Jr.

Fullerton Manufacturing Corp.
17 Chestnut St., South Norwalk, Conn.
Lucion Fullerton

Gallagher-O'Brion Electric Co., Inc.
915 W. North Ave., Chicago 22, Ill.
Frank A. Gallagher

Gardon City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harvey

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave., West Lynn, Mass.
A. F. Dickerson

General Electric Co., Lamp Dept.
Nela Park, Cleveland 12, Ohio *Willard C. Brown*

General Electric Supply Company
A Division of General Electric Distributing Corp.
1260 Boston Ave., Bridgeport 9, Conn.
W. W. Booth

General Fireproofing Co.
Dennick Ave., Youngstown, Ohio *J. A. Saunders*

General Lighting Products Co.
668 Frelinghuysen Ave., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill. *C. E. Freeland*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Gleason-Tiebout Glass Co.
59-50 54th St., Maspeth, N. Y.
Marshall T. Gleason

Globe Lighting Products Co., Inc.
1710 Flushing Avenue, Brooklyn 6, N. Y.
Isidor Rosenblatt

Godfrey and Wing, Inc.
2110 Superior Ave., Cleveland 14, Ohio
C. G. Wing

Golde Manufacturing Co.
4888 N. Clark St., Chicago 40, Ill.
F. W. Goldberg

Grand Rapids Store Equip. Co.
1340 Monroe Ave., N. W., Grand Rapids 2, Mich.
Kenneth C. Welch

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Grayco Products
3850 N. Kedzie Ave., Chicago, Ill. *A. E. Orelove*

Great Northern Mfg. Corp.
4221 W. Harrison St., Chicago 24, Ill. *D. J. Epp*

Guardian Light Company Inc.
301 Lake St., Oak Park, Ill. *W. S. Akely*

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *Clarence Barron*

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

The Hankins Container Co.
3044 W. 106th St., Cleveland 11, Ohio
Ray T. White

Hartford Electric Light Co.
266 Pearl St., Hartford 5, Conn. *Victor Ouellette*

Harvstone Manufacturing Co.
542 E. 75th St., Chicago 19, Ill. *A. M. Rukind*

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill. *R. R. Hill*

Hendrickson-Heffernan Co., Inc.
45-17 Pearson St., Long Island City 1, N. Y.
Joseph T. Manucia

Holdenline Co.
2501 Scranton Rd., Cleveland 13, Ohio
H. E. Ingraham

Hollywood Wholesale Electric Co.
6820 Romaine St., Hollywood 38, Calif.
Edward Meyer

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Home Light and Power Co.
810 Ninth St., Greeley, Colo. *C. Gilbert Dresser*

House-O-Lite Corporation
2450 S. Ashland Ave., Chicago 8, Ill.
Jack R. Stone

Houston Lighting & Power Co.
P.O. Box 1700, Houston 1, Texas *W. J. Aschlen*

Hub Electric Company
2219 W. Grand Ave., Chicago 12, Ill.
I. M. Fixman

Hubbard and Company
6501 Butler St., Pittsburgh 1, Pa.
C. C. Warne, Jr.

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Charles K. Lambka

Illinois Power Co.
154 East Main St., (L Box 511 B), Decatur 70, Ill. *Allen Van Wyck*

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Interstate Power Company
1000 Main St., Dubuque, Ia. *P. H. Brown*

Iowa Electric Light & Power Co.
Box 351, Cedar Rapids, Iowa *Sutherland Dow*

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Power and Light Co.
312 Sixth Ave., Des Moines 3, Iowa
N. Bernard Gunsett

Iowa Public Service Co., East Div.
400 Commercial St., Waterloo, Iowa
C. R. Wagoner

Iowa Public Service Co., Sioux City Division
P.O. Box 778, Sioux City 4, Iowa *C. R. Tracy*

Jefferson Electric Co.
Bellwood, Ill. *L. Maurer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J. *D. J. Douglas*

Jeryl Lighting Products Inc.
42 West Cermak Rd., Chicago, Ill.
Charles Meyerson

Joleco Corporation
2515 Baldwin St., St. Louis, Mo. *George Ledbetter*

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill. *J. H. Fahey*

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 208, Wichita, Kans. *H. W. Hobson*

The Kayline Company
2480 E. 22d St., Cleveland 15, Ohio *M. A. Eskins*

Kelso-Burnett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Kerrigan Iron Works, Inc.
1035 Herman St., Nashville, Tenn. *G. E. Daniels*

Keystone Electric Manufacturing Co.
2228-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Ashe*

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Richard C. Piper, Jr.

Leader Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill. *Walter Glass*

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
I. M. Stein

Libbey-Owens-Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Light Control Company
3217 Canitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

(Continued on page 38A)

5 REASONS WHY

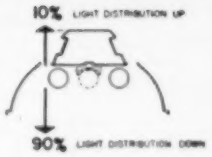
New CFI DAY-LINE

Guarantees More Comfortable, More Productive Plant Lighting

To give industry the comfortable, vision-saving illumination it needs, Day-Brite has completely redesigned its famous Day-Line industrial line. Now—for the first time—industry can have the strong, sturdy construction it needs plus the most important advance in plant lighting in years—10% upward component to provide "comfort for industry."

CFI MEANS COMFORT FOR INDUSTRY

These Features Make the Difference!

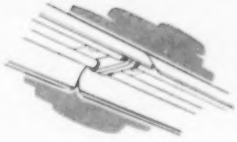


10% UPWARD LIGHT — Eliminates harsh brightness contrasts and dark ceilings that can result in irritation or nervous fatigue due to eyestrain. Workers see better, produce more. Two years of exhaustive research by Day-Brite engineers have proven 10% upward, 90% downward distribution of light is the most practical for industrials.

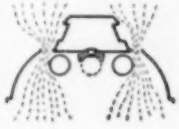
ALL-WHITE PORCELAIN ENAMEL REFLECTORS—Outside as well as inside—further improve the efficiency of the upward component. Embossed apertures are scientifically sized and placed to achieve 10% upward light distribution and still retain the famous Day-Brite strength and rigidity needed for the toughest installation conditions.

LOWER COST—Yet with all the advantages you get with the new CFI DAY-LINE, prices are substantially lower! Better lighting at less cost! Day-Brite Lighting, Inc., 5432 Bulwer Avenue, St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

259



VIBRATION-PROOF TURRET* SOCKETS are standard on all CFI DAY-LINE industrials, including the 85-watt fluorescent lamp units. These finest of all heavy-duty sockets give you positive lamp seating and allow trouble-free lamp mounting. Servicing is quicker and easier. * ® G. E. Co.



COOLER, CLEANER PERFORMANCE—Constant air-flow through the apertures, around the lamps, and over the inside and outside of the reflector keeps CFI DAY-LINE fixtures cooler, more efficient . . . and reduces light loss due to dust and dirt deposits. Circulating air keeps reflectors cleaner . . . longer.

Distributed Nationally by Leading Electrical Wholesalers

Sustaining Members

(Continued from page 38A)

Lighting Products, Inc.
2250 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 56th St., New York 16, N. Y. *H. Stollnitz*

Line Material Co., Division of McGraw Electric Co.
800 North 8th St., Milwaukee 1, Wis. *M. C. Hersh*

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

Lithonia Lighting Products Co., Inc.
Lithonia, Georgia *Robert J. Freeman*

Louisiana Power & Light Co.
142 Delaronde St., Station "A," New Orleans, La.
C. L. Osterberger

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

T. R. Lyda, Manufacturers Rep.
50 E. Georgia St., Indianapolis, Ind. *T. R. Lyda*

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
P.O. Box 950, Newburgh, N. Y. *Norman Macbeth*

Malden Electric Co.
157 Pleasant St., Malden, Mass. *Donald S. Bennett*

Markel Electric Products, Inc.
129-14th Seneca St., Buffalo 5, N. Y.
Morris L. Markel

Markstone Manufacturing Co.
2460 W. George St., Chicago, Ill. *Martin Schwartz*

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada *Henri Martineau*

Metalcraft Products Co., Inc.
Masher & Lippincott Sts., Philadelphia 33, Pa.
Nathan Bloom

Metal Window Institute
Cheltenham, Pa. *George Hingston*

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
T. O. McQuiston

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill. *Fred Pedrigi*

Midwest Chandelier Co.
15th & Gentry Sts., No. Kansas City 16, Mo.
Sidney Lefkovitz

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
98 Angelica St., St. Louis 7, Mo. *Reed Muir*

Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson, Miss. *B. M. Davis*

Mitchell Manufacturing Company
2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

Mitchell Manufacturing Co., Ltd.
19 Waterman Ave., Toronto 15, Ont.
J. E. Landers

Modern Light Company
7809 Maplewood Industrial Court,
Maplewood 17, Mo. *J. E. Baker*

Modern Light & Equip. Co.
3812 S. Wabash Ave., Chicago, Ill.
M. L. Offenberg

Moe Bridges Corp.
1415 Illinois Ave., Sheboygan, Wis. *M. B. Deutsch*

Moe Light, Inc.
700 Oak St., Fort Atkinson, Wis. *Stanley Warner*

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

Mountain States Power Co.
256 Lyon St., Albany, Ore. *A. T. Peterson*

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall,
Pasadena 1, Calif. *E. L. Bettannier*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg., New York 1, N. Y.
Morris Thau

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I.
C. R. Broadhead

National Chemical & Manufacturing Co.
Luminall Paint Div.
3617 So. May St., Chicago 9, Ill.
John Marshall Ziv

Nelson-Tombacher Company Inc.
81 Prospect St., Brooklyn 1, N. Y.
M. J. Tombacher

New Bedford Gas & Edison Light Co.
695 Purchase St., New Bedford, Mass.
W. S. Fenstermacher

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La. *S. L. Drumm*

New York State Electric & Gas Corp.
62 Henry St., Binghamton, N. Y.
Earle C. Edwards

Niagara Mohawk Power Corp.
300 Erie Blvd. W., Syracuse 2, N. Y.
Leland D. McCormac

Northern Electric Co. Ltd.
1620 Notre Dame St., West, Montreal, Quebec
F. P. Labey

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind.
J. C. Sackman

Northern Light Company
1657 No. Water St., Milwaukee 2, Wis.
Fred Cramer

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *C. L. Dunn*

The Ohio Power Co.
301-315 Cleveland Ave., S. W., Canton 2, Ohio
C. B. Morin

The Ohio Public Service Co.
P.O. Box 6058, Cleveland 1, Ohio *C. L. Dunn*

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla. *E. W. Gray*

Omaha Public Power District
720 Electric Bldg., Omaha 2, Nebraska
E. E. Schwalm

Pacific Gas & Electric Co.
245 Market St., San Francisco 6, Calif. *O. R. Doerr*

Pacific Power & Light Co.
522 Public Service Bldg., Portland 4, Oregon
C. A. Root

Peerless Electric Ltd.
1090 Pratt Ave., Outremont, Quebec
L. A. Van Duzer

William Penn Fluorescent Light Mfrs.
1659 S. Broad St., Philadelphia, Pa.
William Ranieri

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa. *Frank R. Knowles*

Pennsylvania Power Co.
19 E. Washington St., New Castle, Pa.
P. G. Dingledy

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa. *J. M. Stedman*

Pennsylvania Wire Glass Co.
1612 Market St., Philadelphia 3, Pa.
Dr. Frank W. Preston

The Perfoclite Company
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, Jr.

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa.
R. G. Rhincliffe

Philadelphia Electrical & Mfg. Co.
1200-56 N. 31st St., Philadelphia 21, Pa.
R. A. Manwaring

Phoenix Glass Co.
Monaca, Pa. *D. G. Cameron*

Pierce Electric Co.
567 W. Adams St., Chicago 6, Ill. *John H. Pierce*

Pittsburgh Corning Corp.
307 Fourth Ave., Pittsburgh, Pa.
Robert W. McKinley

Pittsburgh Plate Glass Co.
Grant Bldg., Pittsburgh 19, Pa. *R. B. Tucker*

Pittsburgh Reflector Co.
403-411 Oliver Bldg., Pittsburgh 22, Pa.
H. C. Zinsmeister

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *T. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md.
S. S. Bradford

Powerlite Devices, Limited
1870 Davenport Road, Toronto 9, Ont.
M. B. Hastings

Public Service Co. of Colo.
900 Fifteenth St., Denver, Colo. *G. B. Buck*

Public Service Co. of Indiana, Inc.
110 N. Illinois St., Indianapolis 9, Ind.
G. O. Stewart

Public Service Co. of Northern Illinois
72 W. Adams St., Chicago 3, Ill. *G. K. Hardacre*

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J. *H. P. J. Steinmetz*

Puget Sound Power & Light Co.
860 Stuart Bldg., Seattle 11, Wash.
Frank McLaughlin

Quadrangle Mfg. Co.
32 So. Peoria St., Chicago 7, Ill.
Dwight E. Worrell

Quaker City Electric Mfg. Co.
2810 East Pacific St., Philadelphia, Pa.
Reuben Haberman

Quebec Hydro-Electric Commission
107 Craig St., West, Montreal, Que.
Paul E. Poitras

Quebec Power Company
P.O. Box 1607, Quebec, Que. *Jean Saint-Jacques*

Rambusch Decorating Co.
40 W. 13th St., New York 11, N. Y.
Edward Rambusch

Revere Electric Mfg. Co.
6009-17 N. Broadway, Chicago 40, Ill.
Van N. Marker

Revere Electric Supply Co.
757 West Jackson Blvd., Chicago, Ill.
Arthur Peterson

Rochester Gas & Electric Corp.
89 East Ave., Rochester 4, N. Y. *L. C. Twitchell*

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
W. T. Reedy

Ruby Lighting Corp.
1212 S. Olive St., Los Angeles 15, Calif.
Albert Jassim

(Continued on page 39A)

(Continued from page 38A)

Ruby-Philite Corp.
32-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa. *T. W. Lauer*

Ryall Electric Supply Co.
1160 Stout, Denver, Colo. *C. O. Ryall*

The Safety Car Heating & Lighting Co.
P.O. Box 904, New Haven 4, Conn. *J. J. Kennedy*

St. Joseph Ry., Light, Heat & Power Co.
520 Francis St., St. Joseph 2, Mo. *F. P. O'Connor*

Sandee Manufacturing Co.
5050 Foster Ave., Chicago, Ill. *R. L. Schramm*

Sandel Manufacturing Co.
3618 So. Loomis Place, Chicago 9, Ill. *A. L. Sandel*

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif. *H. G. Dillin*

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

Schomer Electric Supply
164 S. Broadway, Aurora, Ill. *C. Petrik*

The Albert Sechrist Mfg. Co.
1717 Logan St., Denver 5, Colo. *K. L. Francis*

L. J. Segil Co.
2500 W. North Ave., Chicago, Ill.
Louis Rosenstein

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que.
Chas. H. Talbot

The Sherwin-Williams Co.
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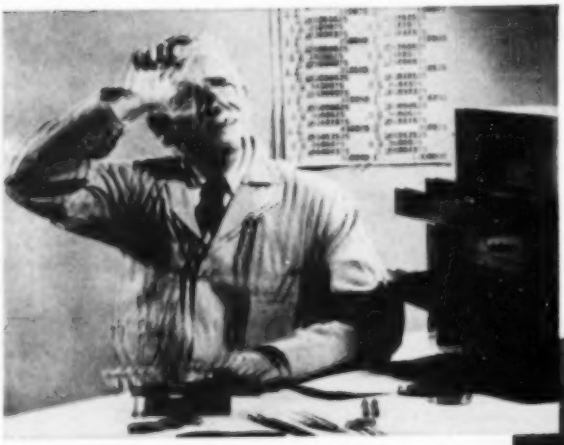

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For all replacement needs—use the famous Watch Dog no-blink starter with the red reset button.

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See Page 2A This Issue

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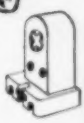

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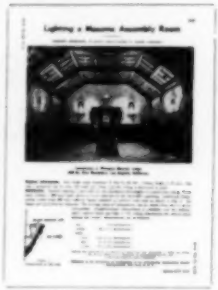

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35 YEARS OF ENGINEERING PROGRESS
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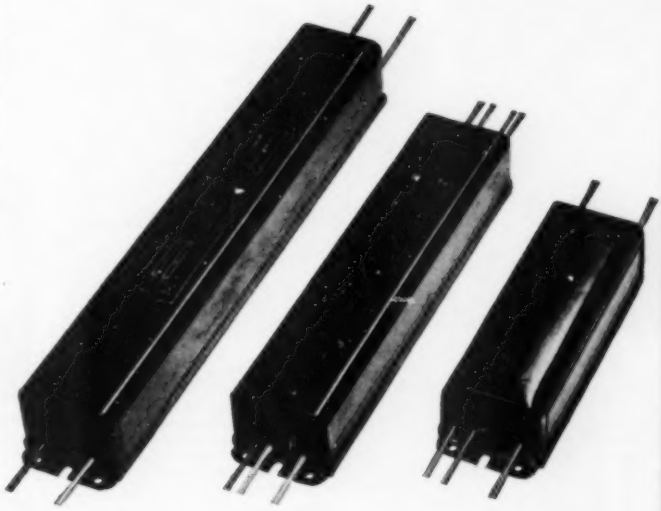

Let's be realistic. Fluorescent lamps need exactly the watt input for which they were designed; a 100 watt lamp will not deliver its full light output if it is limited by a ballast having an actual output of only 91.2 watts. A low watt input to lamp results in a low light output. Low pre-heat current and an excessive operating current means short lamp life. Distorted lamp current wave form leads to excessive cyclic flicker.

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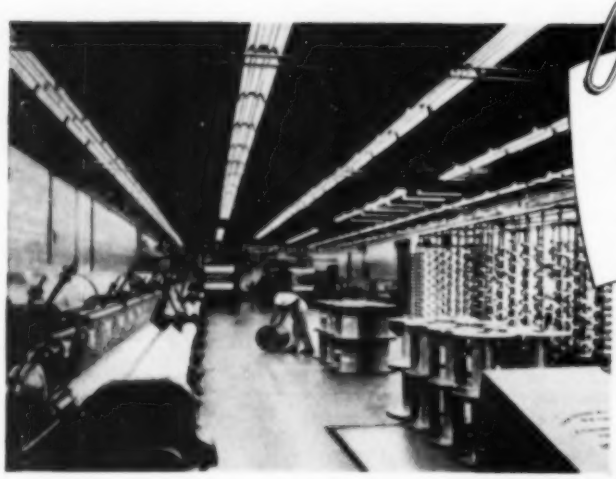
WILL PAY FOR ITSELF IN 3 YEARS!



Photographic record shows why Sylvania Fluorescent Lighting speeds production . . . saves big money for Southern Mill

Looking for ways to cut costs? Here's a Sylvania Fluorescent Lighting Installation that does just that for the Deering-Milliken Mills in South Carolina.

Note the clean, clear lighting atmosphere in the above photo. Sylvania tubes and fixtures furnish a lighting level practically triple that obtained from former lighting units. As a result, mill authorities estimate, the saving realized in production costs, time, and the elimination of waste *will completely pay for this efficient installation in just three years time.*

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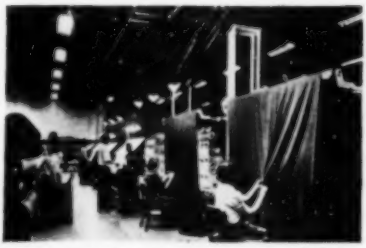
$1500 Saved Here. This unique inspection method uses 24 forty-watt Sylvania fluorescent tubes and a luminous panel. Mill engineers estimate this Sylvania-designed unit provides a saving of $1500 per year.



Inspection speeded here. Excellent use is made of the flexibility of Sylvania Fixtures. Hung at an angle over the cloth they eliminate need for slow, costly hand portable droplights and greatly speed inspection. Another big saving with Sylvania.

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